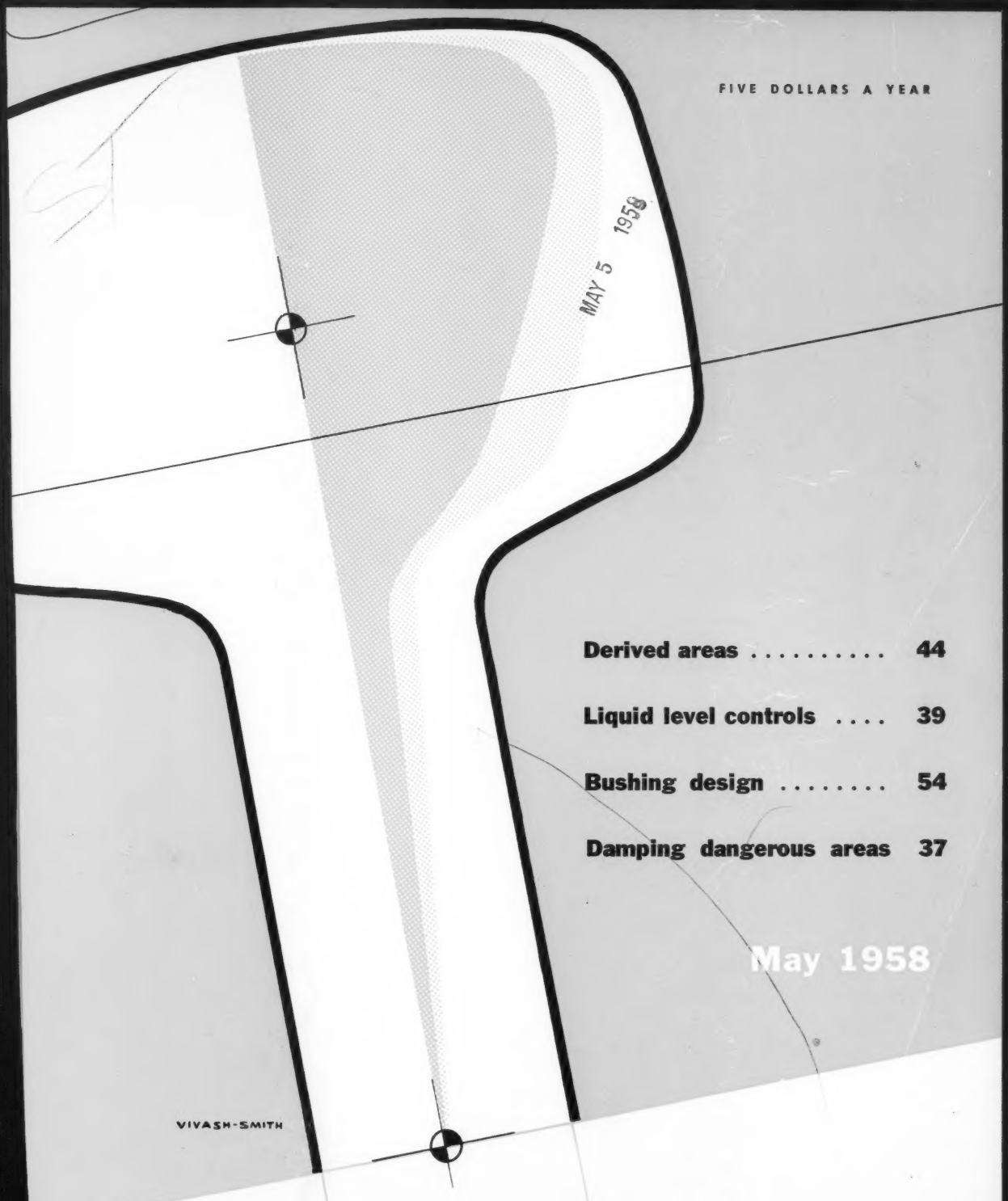
Design Engineering



FIVE DOLLARS A YEAR

May 1958

UBLISHED BY THE MACLEAN-HUNTER PUBLISHING COMPANY LIMITED, TORONTO, CANADA

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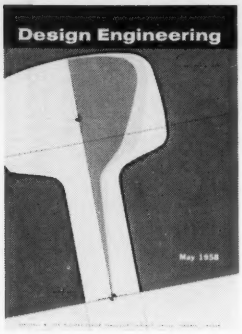

Design Engineering

VOL. 4 MAY 1958 No. 5

This month's cover

Brilliant in its suit of orange and black, the May cover is the work of the artist team of Al Vivash and Eloise Smith. It depicts derived areas, the light shading being a first derived area and the heavy shading a second derived area. The technique of derived areas is useful in finding the sectional characteristics of beams and so forth.

Design Engineering

MEMBER

CCAB

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Tiny Tankers. Unicellular diatoms floated on prehistoric seas in infinite numbers, each encased a microscopic fat globule. Today, coalesced, they comprise the oil pools we draw upon. A wonder-of-the-world in miniature, truly a miracle of nature.

Magnetic Oil Finder. Modern triumph of miniaturization is the sensitive aerial magnetometer which trails an airplane for magnetic field surveys, locating new oil resources. 29 MPB bearings in it reduce friction for measuring accuracy 1 to 2 parts per 50 thousand.

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D. A. Bamford, BASc, PEng (Short course in liquid level controls), is a graduate in electrical engineering from the University of Toronto. He worked for Radio Valve Co. until 1946 when he formed Measurement Engineering and has managed it ever since. Hobbies are boys' work and photography.

VANDEVENTER

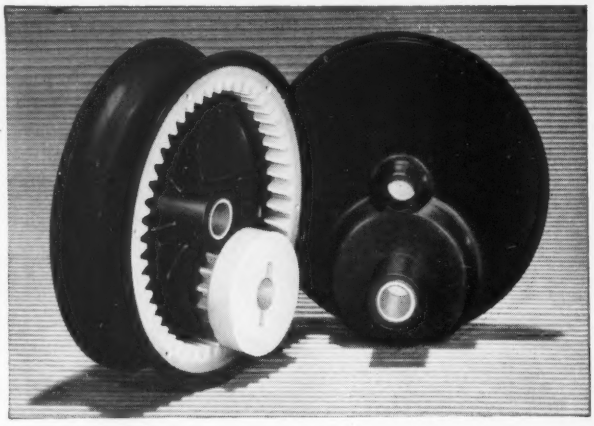
David Vandeventer (What is a load cell—how does it work?), is a BA in electrical engineering, Antioch College, 1941. He has taken graduate courses at the University of Pennsylvania and taught at Temple Technical Institute evening classes. Joining Leeds and Northrup Co. where he is now head of the industrial processes section, he has long been interested in the application of load cells. He has responsibilities connected with Red Feather, Boy Scouts and musical organizations.

DU PONT CANADA

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

Drive Gear, Pinion and Clutch of "Zytel" nylon is a feature of new self-propelled mower.

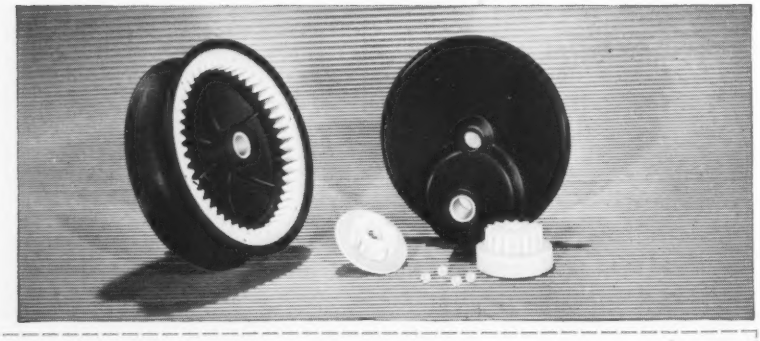


Power Lawn Mowers Ltd., of London, Ont. get better performance at lower cost through good design, versatility of the moulding process, *plus* the best material for the job.

The fact that nylon wheel-bearings, in use for some years, had solved one of their most troublesome problems, led Power Mowers Ltd. to consider the material for the drive mechanism in a new, self-propelled mower.

Any material used for this purpose would have to perform well under difficult conditions — little, if any, lubrication, dirt, shockloads, vibration — and experience with the wheel bearings indicated the superiority of nylon in service of this kind.

The availability of good data which can be used to determine optimum design for "Zytel" nylon parts was a further indication that the necessary parts could be made successfully.



The presence of a qualified moulder, Robinson Industrial Crafts, in London, Ont. was an important factor since the successful production of mechanical parts requires attention to details not normally of concern to moulders of less critical articles.

The mechanism consists of two main gears mounted inside the rim of the two rear wheels. These gears are driven by pinions which, in turn, are integrally moulded to a clutch of the ball and slot type which engages to drive the wheels forward and automatically disengages when the machine is pulled backward. A steel shaft, working through a nylon bushing, connects the clutch and pinion to the crankshaft. The ability to mould the pinion and the clutch in one part is typical of the versatility which often produces outstanding savings in the manufacture of mechanical parts by the injection moulding method.

"Zytel" nylon, the injection moulding process, and good designing are together producing substantial cost reductions for hundreds of Canadian and American manufacturers. It could do the same for you . . . why not discuss it with your moulder or call a Du Pont Sales Engineer. You will not be obligated in any way.

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Please send me more information on the Du Pont plastic engineering materials checked: ☐ *"Zytel";* ☐ *"Alathon";* ☐ *"Teflon";* ☐ *"Lucite". I am interested in evaluating these materials for*

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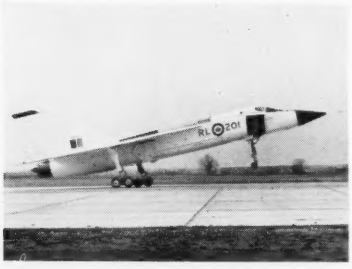
Reports

A news roundup of items of engineering and design interest from the world over

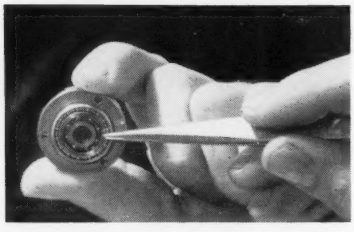
Supersonic plane confounds the critics and flies



After the fanfare surrounding the public showing of the Arrow, Canada's first supersonic aircraft, the boys out at Malton wasted little time getting the aircraft and test pilot Jan Zurakowski into the air for a test flight.

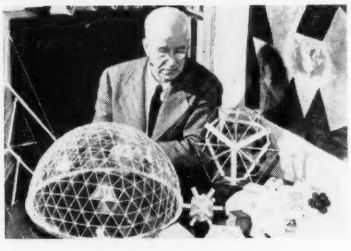
It was in July 1953 that the Government authorized a design study of the CF.-105, the code name given to the Arrow. Within two months the first wind tunnel tests were being run at speeds up to twice the speed of sound. The recent test flight did not make use of the Iroquois power plant because, although its development is well advanced, the combination of untried engine and untried airframe wasn't considered practical on an aircraft development flight test program.

New development gives gyros a new accuracy



A closely held secret for over a year, the news is now out on how inexpensive and accurate gyro systems for stabilizing and guiding can be achieved. It is made possible by the development of "frictionless" gyros. The principle eliminates error-producing torques in gyro gimbals, the major cause of random drift error in the critically important direction-sensing devices. What's more, it does this without significant increase in weight, cost, complexity, manufacturing or maintenance problems. Random drift error improves by as much as 1,200%. Picture at left shows the coaxial bearing developed for use in this system.

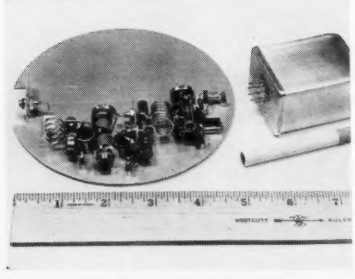
ASM is building a showplace east of Cleveland



By all accounts, the American Society for Metals is really going to town on the new headquarters building it plans to build just east of Cleveland. The building will feature the world's largest geodesic dome or "space lattice" (brain child of R. Buckminster Fuller) made of aluminum tubing. Weighing 166,000 pounds, the dome will be raised by inflating a system of plastic balloons.

Also on the drawings are a 400-ft. diameter garden piazza and a giant copper "sun shield." The ASM hopes to have its showplace headquarters completed by mid-1959.

A transmitter diets to cigarette pack size



Impressively small is this "broadcasting station" which weighs less than three ounces and has a volume of under six cubic inches (less than a package of cigarettes). For a power output of 500 milliwatts, it uses less than half the battery power needed by any other transmitter now known.

The transmitter is designed primarily for use in the satellite program. Its signals would be used in telemetering information on space conditions to monitor stations throughout the world and as an aid to tracking the satellite's path.

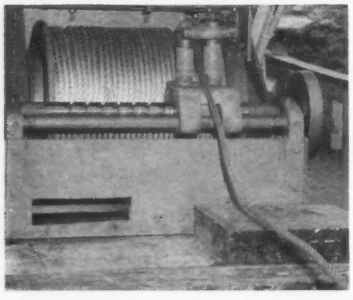
The new circuits employed would make possible a radio transmitter small enough to fit into a shirt pocket or be built into an infantryman's helmet (Dick Tracy fans please note).

Wood finishing technique cuts costs, time too

A technique that will put a smooth, glossy finish to any type of wood at a rate of up to 120 linear ft. per minute has just been announced. By eliminating hand sanding and sealer and second coatings, the new technique cut by at least 75% the cost of finishing doors, cabinets and so forth.

The process uses pressure and friction to create heat which melts lignin, a natural plastic in the wood surface. This is blended with a specially developed synthetic resin. The two together form a dense, extremely smooth and water spot resistant surface about 1/24 in. deep. It is not a film or overlay, but actually part of the wood which can be painted, stained or varnished immediately.

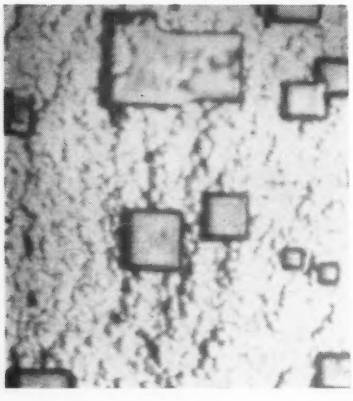
Stainless steel beats salt water towing problem



Important developments are under way at the British Post Office in long-range telephony, in particular the work being done on a new type of lightweight submarine cable. For over 100 years, deep-sea cable has been strengthened by winding a layer of steel wires around a simple cable of insulating materials and copper. This method of construction is heavy and uneconomical in the use of steel; the cable also tends to twist when under tension and to form kinks under some conditions of laying or recovery.

The new cable has no external armor wires. All its strength is provided by a central core of nontwisting 110-130-ton steel rope with a copper conducting coating, the conductor being imbedded in polythene insulation.

Steel crystals that neatly dress by the right

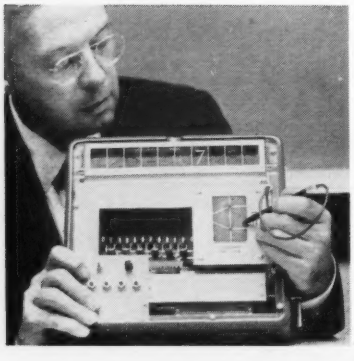


After a twenty-five-year search by the electrical industry, scientists have now announced a new kind of magnetic steel called Cubex. A "cube-oriented silicon-iron," it should find use in the magnetic cores of electrical devices such as transformers and motors.

Originated by German scientists, the steel has undergone considerable development this side of the water where scientists claim to have discovered a new mechanism for crystal growth in metals. The crucial characteristics imparted to the new steel by its unusual crystal orientation is an ability to be magnetized easily in four directions. This permits magnetism to "turn corners" readily in the magnetic core of a piece of electrical equipment.

The crystal arrangement in a sheet of the new cube-oriented magnetic steel might be compared with the arrangement of a tray of ice cubes. Each cube rests flat on one side and squarely faces the ends and sides of the tray.

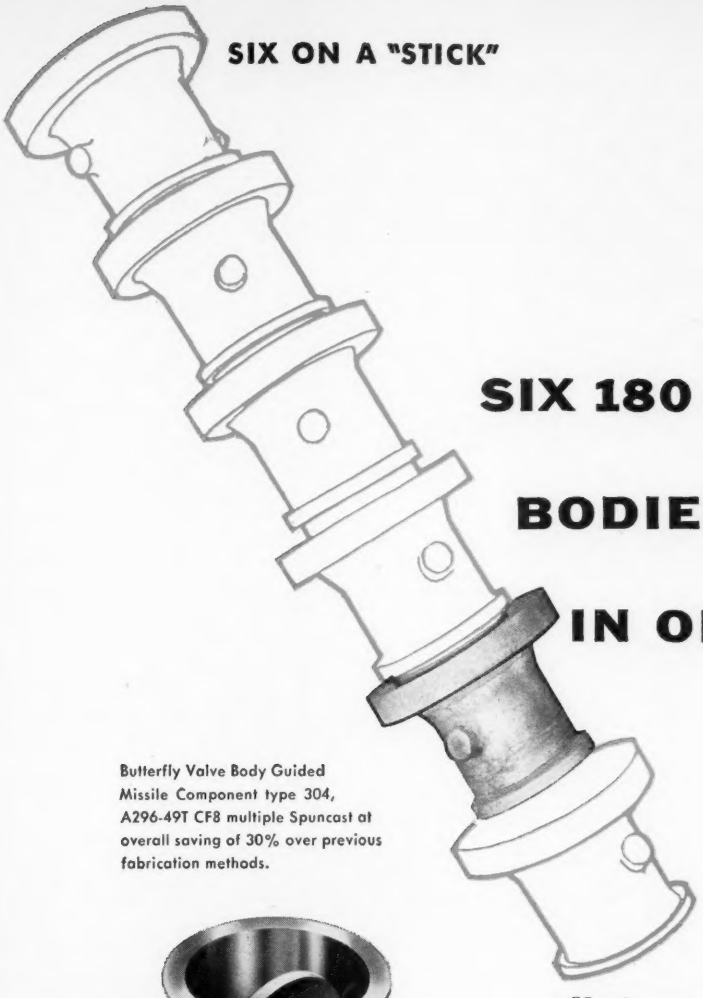
Handwritten numerals can be read mechanically



"Impossible" is a word that science has seldom recognized. An interesting example of this is an experiment device (typewriter size) that can read hand-written numerals or identify numerals as they are being written. The writing is done with a metal stylus on a specially prepared writing surface. Two dots, one above the other, are used as reference points. Seven sensitized lines extend radially from these two dots. Numerals are recognized by the machine, depending on which lines are crossed.

To recognize previously written numerals, it is necessary to write with a pencil containing a conductive lead. The ticket is then inserted in the machine into a special slot under a plate that has seven sensitized lines. The machine determines which sensitized lines have been crossed and indicates the proper number by illuminating a numeral. The device is operated from flashlight batteries and requires no outside power source.

SIX ON A "STICK"



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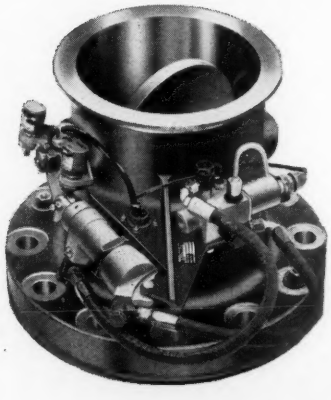

Here's an opportunity to take advantage of one of the most cost saving techniques in modern casting practice—*ESCO* Spuncast Multiple Casting. You can cut fabrication and machining time to a minimum, save on material costs with definite improvement in quality.

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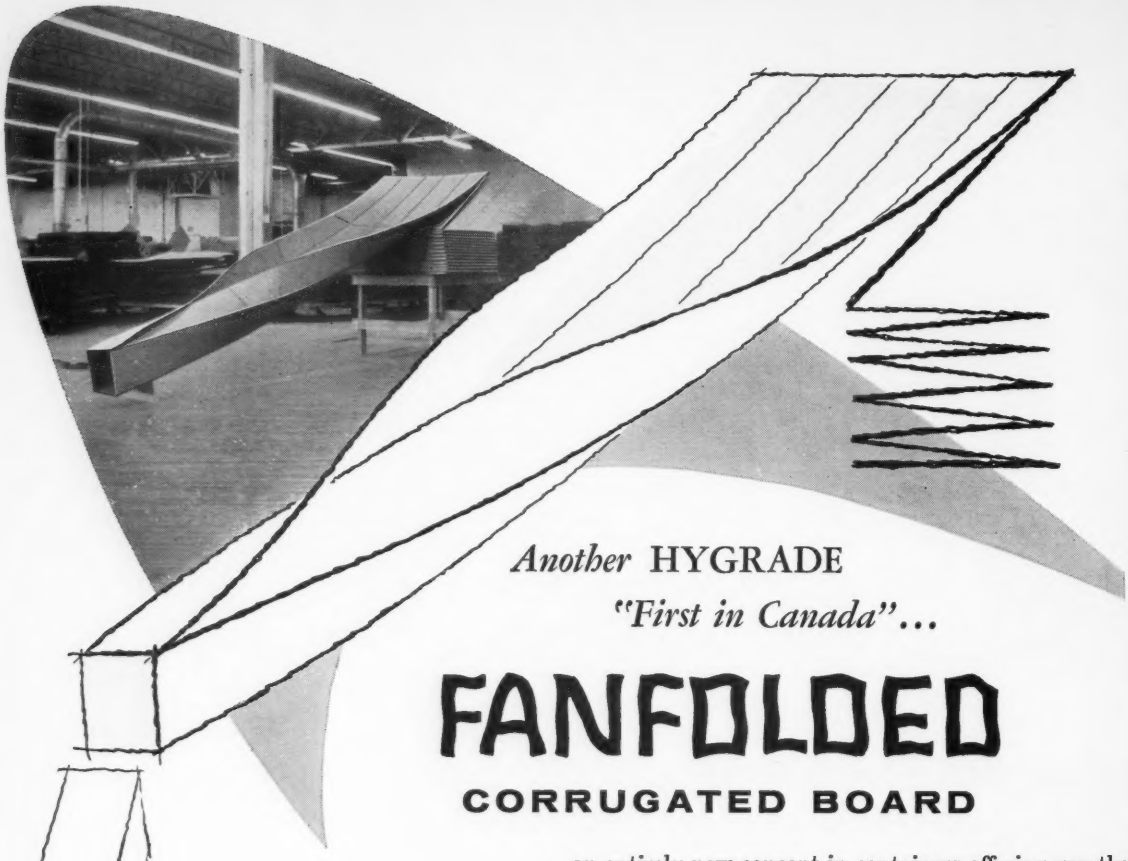

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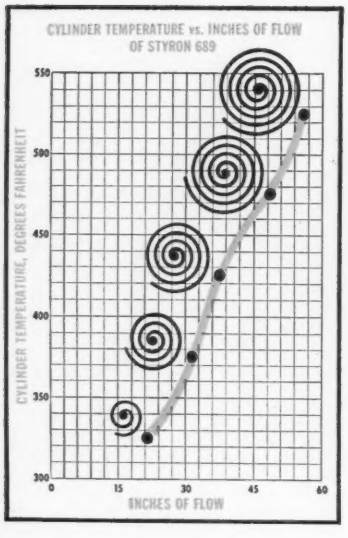
sparkling clear

STYRON 689



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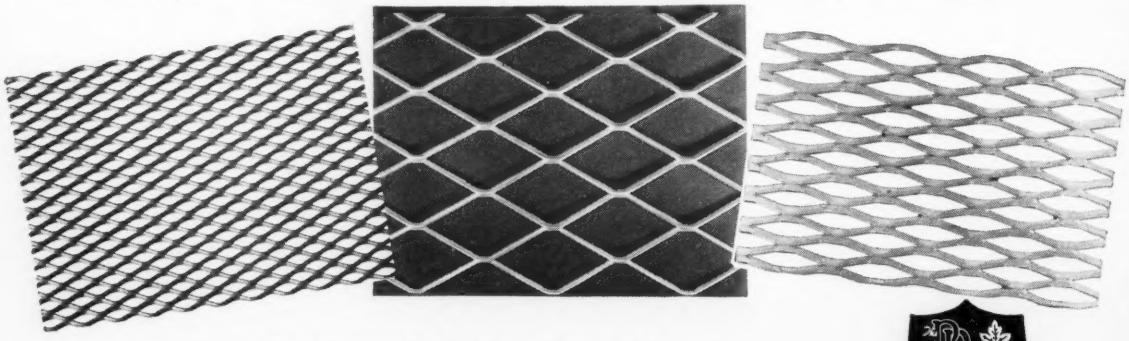

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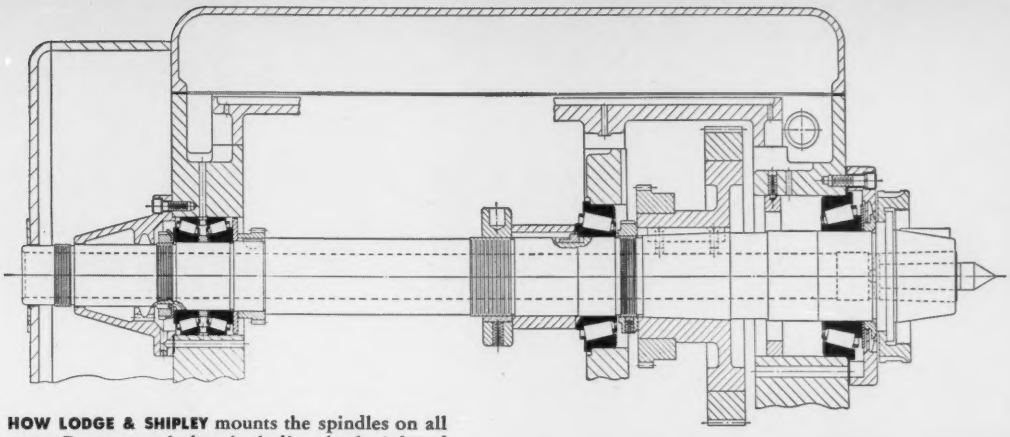

HOW LODGE & SHIPLEY mounts the spindles on all 2013 Powerturn lathes including both 45° and 90° Copymatics on Timken bearings to get extra rigidity, maintain accuracy, reduce maintenance.

New type lathe ups production 200%, saves users an estimated $8,000 a year

...one secret—TIMKEN bearings on the spindle

"Production increases as high as 200%"..."Overall savings estimated at $8,000 a year"—read user reports about the new 2013 Powerturn 90° Copymatic Lathe. One important reason for such exceptional results is that Lodge & Shipley mounts the spindle on Timken tapered roller bearings. Timken bearings give it the vital extra rigidity and hold runout to the minimum needed for tracer accuracy.

How spindle is held rigid. Timken bearings hold the spindle in positive alignment. They take *both* radial and thrust loads in any combination, because of their tapered design. And because of full line contact between rollers and races, Timken bearings have extra load-carrying capacity.

Why heavy shocks are absorbed. Case-carburization of Timken bearings' rollers and races gives them hard, wear-resistant surfaces and tough, shock-resistant cores.

How friction is virtually eliminated. Timken bearings are geometrically designed to roll true. And they're precision-made to live up to their design. They run smoother—last longer.

We even make our own electric furnace fine alloy steel, for extra quality control. To get all these advantages, always specify bearings trade-marked "TIMKEN". The Timken Roller Bearing Company, Canton 6, Ohio, U.S.A. **CANADIAN PLANT:** St. Thomas, Ontario. Cable address: "TIMROSCO".

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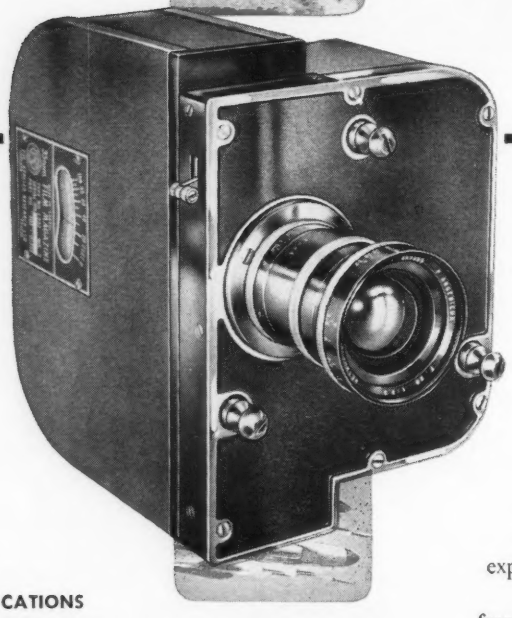
The Perfect Answer to Film Recording

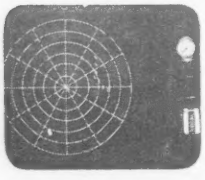


HERE is the perfect answer to the problems of film recording. The Mark 7 Instrumentation Camera is completely flexible through the entire field of instrumentation and aerial survey positioning photography. The shutter is a focal plane type, the basic exposure speed of which is 1/100 second. The camera may be cycled from 3 frames per second to any desired longer interval. Interchangeable apertures permit photographs of 18x25, 25x25 or 25x36 mm. A high degree of accuracy is achieved in respect to lens alignment, focusing and format positioning. Main components designed on the "module" system make conversion from one camera type to another relatively simple should customer requirements change. Write for literature and quotations.

SPECIFICATIONS

INSTRUMENTATION CAMERA TYPE T232 Mk7

Size:	7½" x 5⅞" x 6½"
Weight:	13½ lbs.
Power:	28 volts DC; constant demand, .4 amperes; intermittent up to 1.8 amperes. The Type T232 DC power supply, which operates from 110v 60 cps, is available to power the camera
Lens:	28mm Augenieux F3.5, or to customer specification
Magazine:	100 ft. 35mm standard sprocketed film, No. 10 daylight loading spool. 400 ft. magazine available on special order
Picture Formats:	18x25, 25x25 or 25x36 mm.
Exposure:	1/100 second, or longer with intervalometer control
Interval Time:	3 cycles per second maximum



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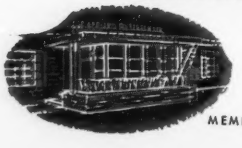

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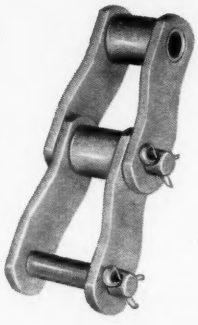
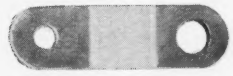
TORONTO 16, ONTARIO, CANADA
PLYMOUTH 5-3371

MEMBER: A. V. ROE CANADA LIMITED & HAWKER SIDDELEY GROUP

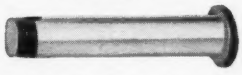
"Stress raisers" eliminated by Link-Belt LXS chain design

LXS "FULL-ROUND" DESIGN

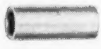




"Full-round" pitch holes . . . no sharp corners



"Full-round" pin



"Full-round" bushing

"FULL-ROUND" DESIGN eliminates stress concentration points. Heat treatment of all parts adds even greater strength and extra wear life to selected steels. Accurate control of these processes avoids brittleness, poor wear values and low tensile strengths . . . and assures uniformity.

Large pins, bushings mean ample live bearing area for long life

For long life under severe conveyor and drive conditions, Link-Belt LXS chain provides extra strength, increased wear resistance and wider application flexibility. This fabricated steel roller chain incorporates many advanced design and manufacturing refinements, resulting in superior ruggedness and accuracy.

Eliminate weak points

"Full-round" design does away with stress concentration points most frequently subject to failure . . . provides maximum live bearing area between pin, bushing and sidebars. As a result, stress is distributed evenly, increasing chain life.

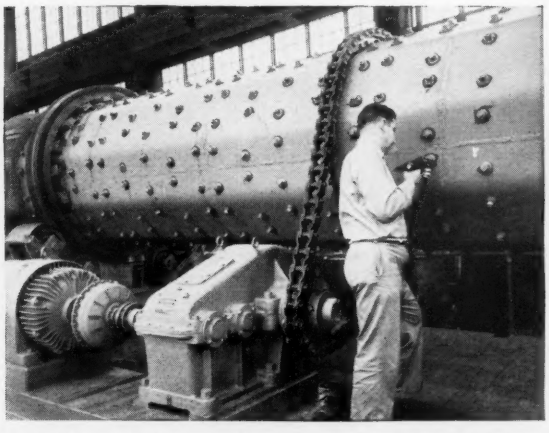
Pins and bushings are accurately sized for controlled press fit, preventing rotation in sidebars. Made from selected bar steel, sidebars are carefully machined for proper pitch hole size and for maintaining firm, tight press fit of pins and bushings. This assures close control of pitch and proper chain length after assembly.

Hardening extends life

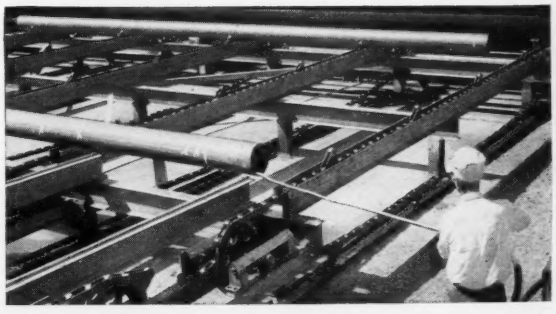
Another Link-Belt long-life extra is the controlled hardening of selected steels used in the manufacture of LXS chain. Pins, for example, are made from a tough steel, specially treated for high strength in shear and for maximum wear value. Bushings are properly hardened to shrug off shock and resist wear.

Rollers are accurately machined to assure proper operating clearances and free-rolling action. Controlled hardening gives them the necessary resiliency and durability.

LXS especially popular for exposed drives, high impacts



Link-Belt LXS chain is the long-life answer for exposed drives, abrasive and high-impact conditions. Its large, live bearing area reduces cutting action of abrasives because load is spread over a broad area.



LXS chain provides extra strength, wear-life for heavy-duty conveying

Link-Belt LXS chain has real stamina—as shown in this conveyor application for handling 1000-pound, 40-foot lengths of steel pipe. Thanks to accuracy of pitch and attachment spacing, plus close matching of multiple strands, LXS has the added strength and wear life for the extra-long conveyors so popular in today's move to mechanization.

HEADQUARTERS FOR CHAINS, SPROCKETS is your nearby Link-Belt factory branch store or authorized stock-carrying distributor. Write for Catalog 900.

LINK-BELT

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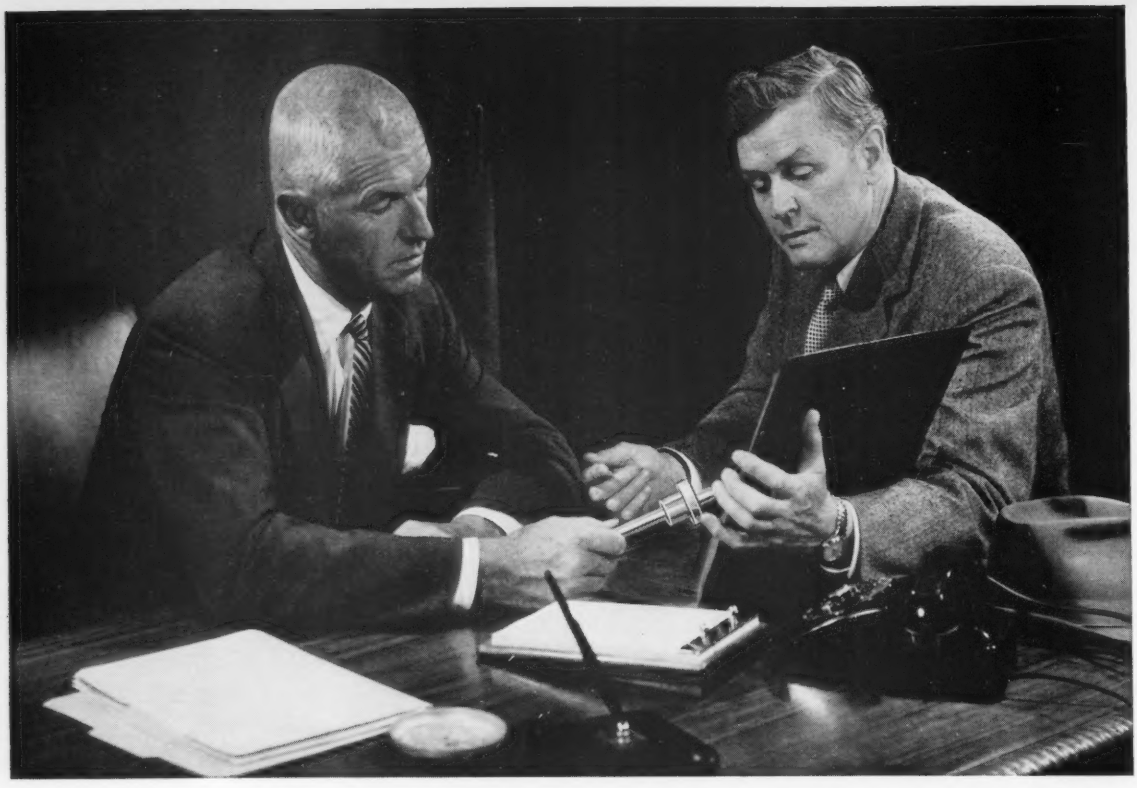
LINK-BELT LIMITED: Scarboro Plant, General Offices and District Sales—Scarboro, Ont., Station H, Toronto 13 • Eastern Avenue Plant and Factory Branch Store—Toronto 8 • Sales Offices and Factory Branch Stores —Montreal 15 • Vancouver 12 • Winnipeg 10 • Swastika, Ont. • Halifax: Austen Bros. Ltd. • District Sales Offices—Hamilton • Sydney: Austen Bros. Ltd. • Foundry at Elmira, Ont. 14,258-C



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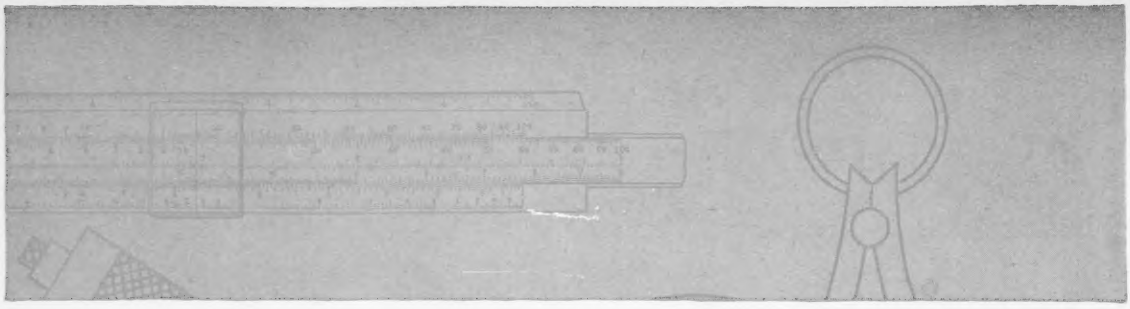
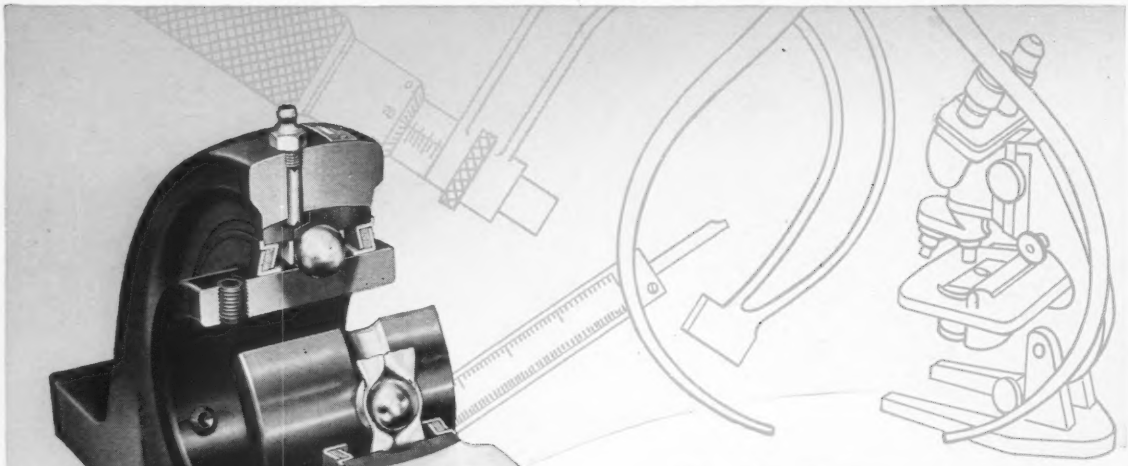


SYMBOLS OF PRECISION



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Canada Iron manufactures all grades and types of cast iron, for convenience classified as follows and complying fully with A.S.T.M. A48 where applicable. Here are some typical examples:

DOMITE "30":
Better than average cast iron.
Minimum tensile strength 30,000 psi.
Typical Brinell hardness 200.

DOMITE "40":
High strength, medium cross-section.
Minimum tensile strength 40,000 psi.
Typical Brinell hardness 235.

DOMITE "50":
High strength, heavy cross-section.
Minimum tensile strength 50,000 psi.
Typical Brinell hardness 260.

DOMITE WEAR RESISTING:
Type WR—A, B, C and D (type depending on service involved).

DOMITE HEAT RESISTING:
Type HR—A, B, C and S (type depending on service involved).

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Alloyed white iron, Brinell 600—725.

NI-RESIST:
High nickel alloy cast irons for corrosion and heat resistance. Tensile strength 25,000 to 30,000 psi, Brinell 130—180.

DUCTILE NI-RESIST:
Composition and properties as for Ni-Resist, but with 60,000 psi, tensile strength and 10% elongation, strong and shock resistant.

NODULOY, DUCTILE IRON:
Nodular or ductile cast iron in a complete range of properties, from 60,000 psi tensile and 20% elongation at 160 Brinell to 180,000 psi tensile at 330 Brinell. Available also in special heat resistant grades.

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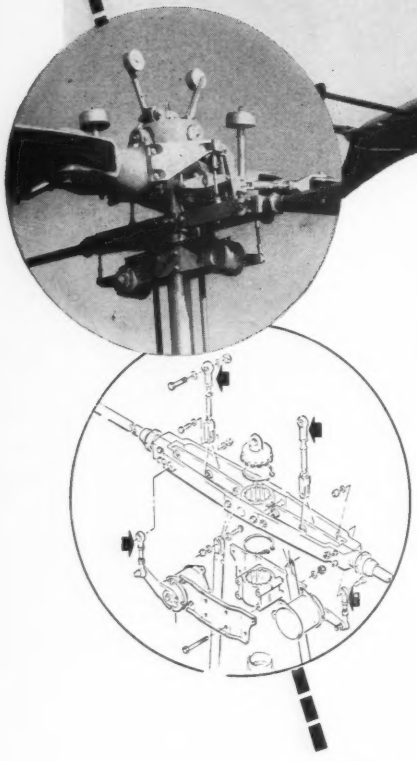

THE NEW "BELL RANGER" HELICOPTER USES HEIM UNIBAL ROD ENDS

Model 47-J is the latest helicopter to be introduced to the commercial market by Bell Helicopter Corp., and has been named the Bell Ranger. It is a four-place, executive type machine with a deluxe interior or a series of quick-change cabin arrangements for cargo, litter, and internal hoist configurations.

HEIM Unibal Rod Ends were chosen for the linkages in the carburetor heat and mixture control installations, and in the main rotor stabilizer bar assembly. The rods link hydraulic dampers to the bar, which provides exceptional stability to the flight characteristics of Bell helicopters, acting like a gyroscope and, through mixing levers, keeps the rotor plane of rotation in its pre-established flight path.

THE HEIM *Unibal* is the spherical bearing which corrects misalignment in every direction because of the universal movement of the ball — Reduces friction and lost motion in linkages — Eliminates the effects of vibration — Lowers assembly costs because of its quick and easy installation — Carries heavier loads.

Perhaps Heim can help solve — or simplify — your linkage problems. Feel free to write. Be sure each engineering and purchasing department has a Heim catalog.

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Here's PROOF of savings...

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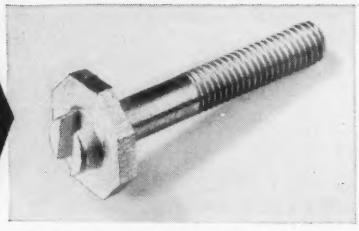
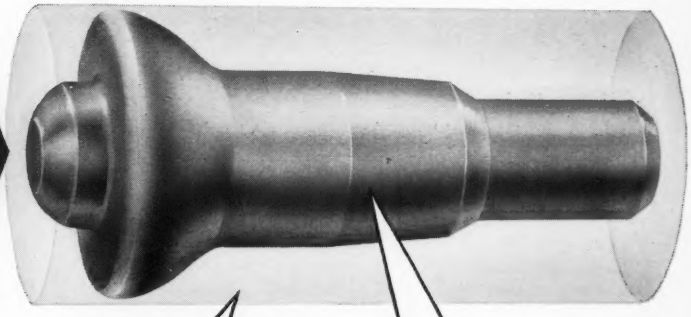


Enlarged view of part previously produced by machining.

Part as now produced by STELCO Cold Heading at half the cost.

Manufacturer 'B' uses 63.5% less material



Material blank previously used for machining (actual length 2¼") .550 lbs.

Finished part, cold headed by STELCO. Material used .200 lbs.

Any part that can be machined from rod stock is potentially suited to production by cold heading. This technique offers speed of production* without scrap loss — and therefore low unit costs. Costs remain attractively low even when one or more secondary operations is required. In addition, cold working increases the tensile strength of the metal, and produces an excellent surface finish.

Quality of cold headed products is high, because metals must be resistant to cracking and free from defects to be satisfactorily upset or extruded cold.

Stelco's Engineers can tell you quickly whether *your* fasteners or contoured parts can be made by cold heading. If so, the savings are likely to be considerable. Send in your specifications with a drawing and an idea of the application, and you will receive prompt attention.

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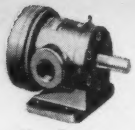
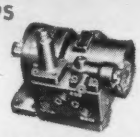
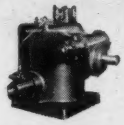
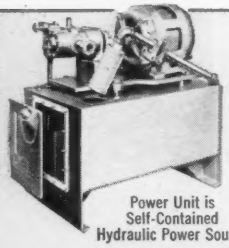
PUMPS


Vane Pump


Two Stage Vane Pump (2000 psi)


Double and Two-Pressure Vane Pumps

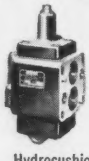

Variable Delivery Piston Type Pump

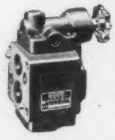

Power Unit is Self-Contained Hydraulic Power Source

PRESSURE CONTROLS


Balanced Piston Type Relief Valve


Hydrocushion Type Sequence Valve


Hydrocushion Type Counterbalance Valve

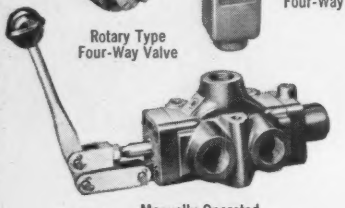

Pressure Reducing Valve

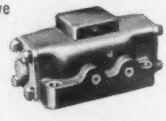

Flow Control Valve with Hydrostatic Compensator

DIRECTIONAL CONTROLS

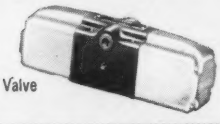

Rotary Type Four-Way Valve


Plunger Type Four-Way Valve

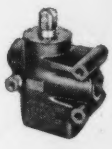

Manually Operated Four-Way Valve


Pilot Operated Four-Way Valve


Solenoid Controlled Pilot Operated Four-Way Valve

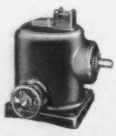

Solenoid Operated Four-Way Valve

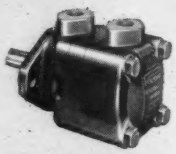

Check Valve


Deceleration Valve

MOTORS


Constant Displacement Piston Type Motor

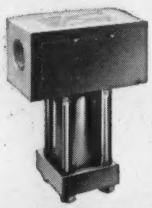

Variable Displacement Piston Type Motor

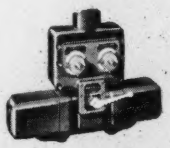

Balanced Vane Type Motor

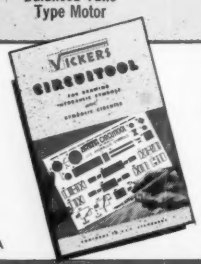

Hydraulic Cylinders

ACCESSORIES


Accumulators


High Pressure Type Micronic Oil Filters


Traverse and Feed Cycle Control Panel



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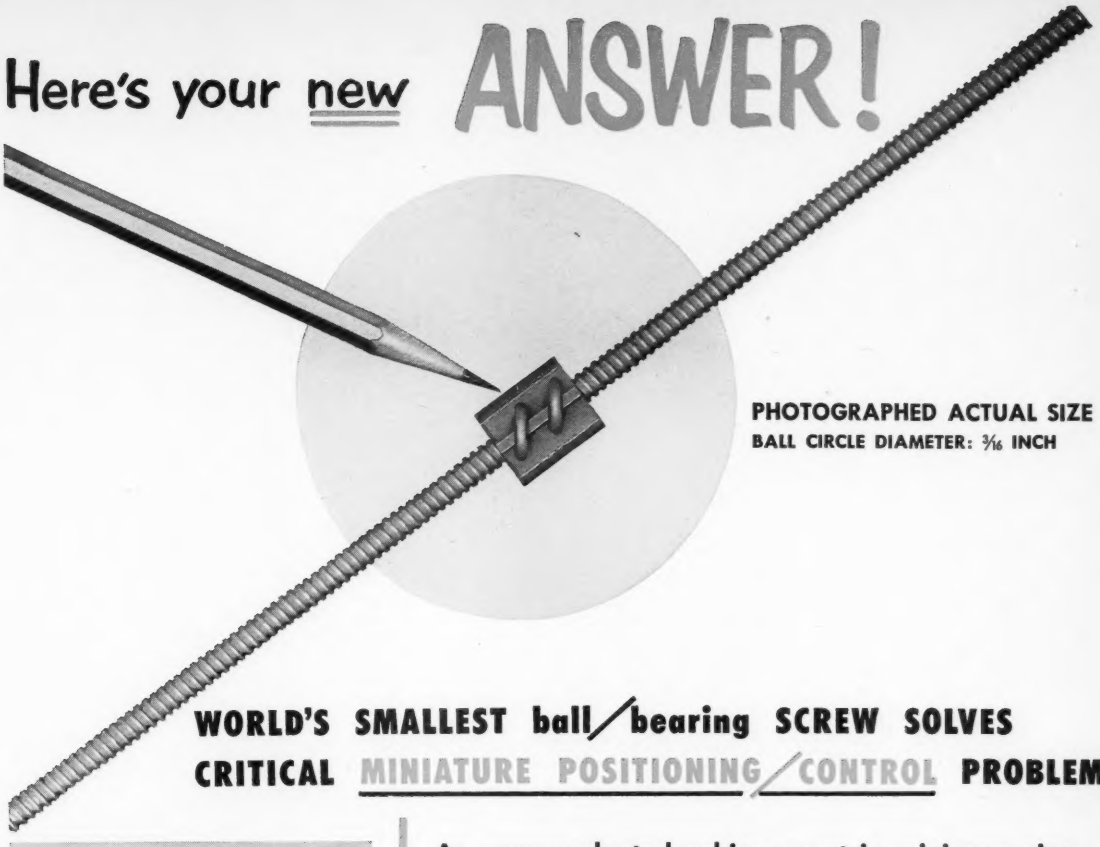
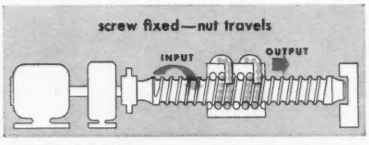
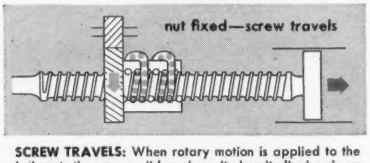


PHOTOGRAPHED ACTUAL SIZE
BALL CIRCLE DIAMETER: 3/16 INCH

WORLD'S SMALLEST ball/bearing SCREW SOLVES CRITICAL MINIATURE POSITIONING/CONTROL PROBLEMS



NUT TRAVELS: When rotary motion is applied to the screw, the b/b nut glides along the axis of the screw on rolling steel balls, converting rotary force and motion to linear force and motion with 4/5 less torque than acme screws.



SCREW TRAVELS: When rotary motion is applied to the b/b nut, the screw glides along its longitudinal axis on rolling steel balls, converting rotary force and motion to linear force and motion with unprecedented efficiency.

An unprecedented achievement in minimum size and weight—maximum efficiency, dependability and service life for ultra-precise controls.

It's another first from Saginaw—and the possibilities it opens up for improved electrical and electronic controls are limited only by your imagination! Radar tuners, missile and rocket guidance and telemetering systems, automatic switchgear, electronic machinery controls are just a few of the applications where this new miniature Saginaw b/b Screw will solve critical positioning/control problems. *It's so compact and light,* you can save substantially on space and weight. *It's so efficient,* (over 90%) you can use much smaller motors and gear boxes. *It's so precise,* you can position components within .0005 inch per inch of travel. *It's so dependable,* you can rely on remarkably long service life even in adverse environments.

You will find our 1958 Engineering Data Book extremely helpful in planning applications, or experienced Saginaw engineers will gladly make specific recommendations without obligation. Just phone, write or mail the handy coupon.

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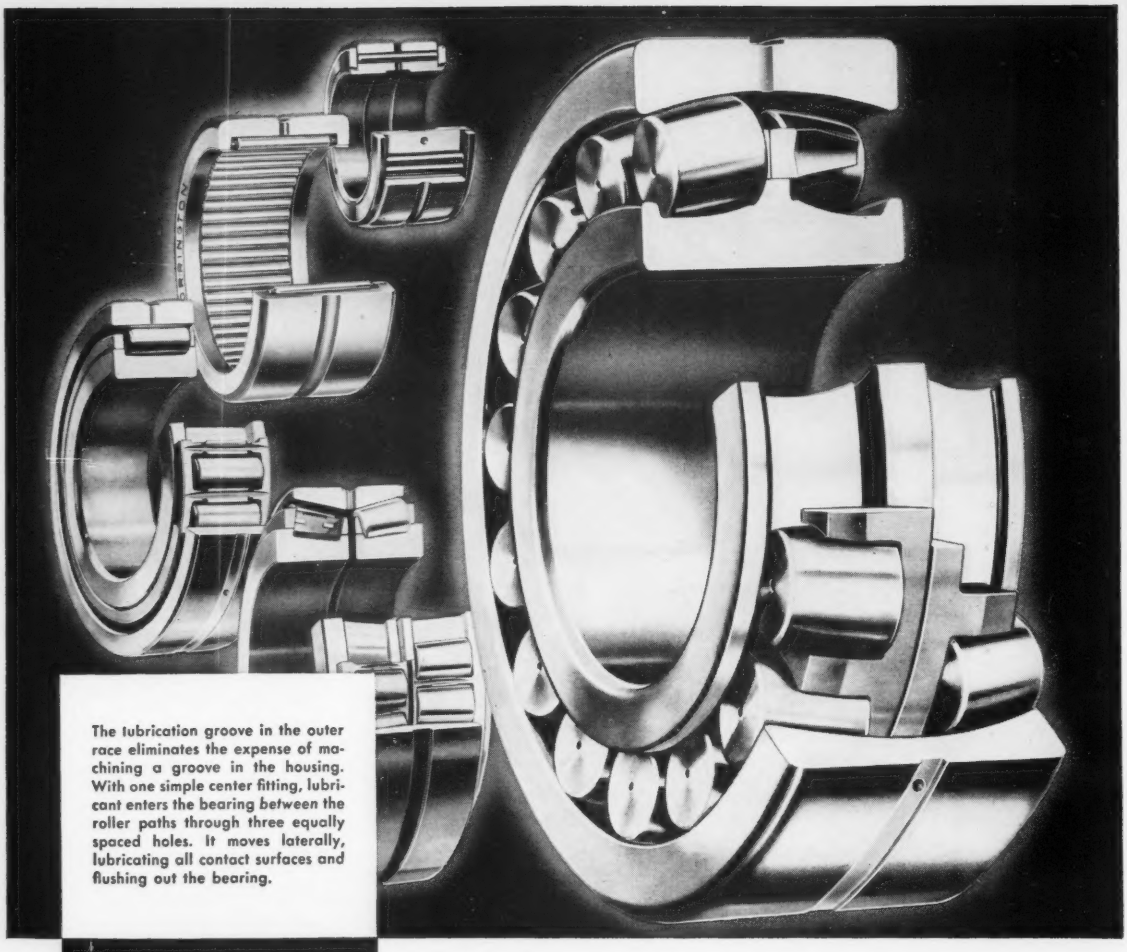
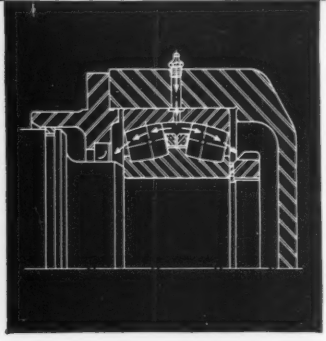


The lubrication groove in the outer race eliminates the expense of machining a groove in the housing. With one simple center fitting, lubricant enters the bearing *between* the roller paths through three equally spaced holes. It moves laterally, lubricating all contact surfaces and flushing out the bearing.



A time-proved lubricating method now available on Torrington Spherical Roller Bearings

The circumferential groove in the outer race has met the test of experience in many Torrington Bearings, including Heavy Duty Needle Bearings, Aircraft Type Needle Bearings, Tapered and Radial Roller Bearings. Now the circumferential lubrication groove is available in Torrington Spherical Roller Bearings.

This design feature makes it possible to introduce lubricant *between* the roller paths without the expense of machining a groove in the housing. This groove is proportioned to provide generous lubricant flow capacity. Lubricant moves through the roller paths, flushing used lubricant and contaminants away from bearing contact surfaces.

Torrington Spherical Roller Bearings in many sizes may be ordered with this groove as desired at no additional cost. For further information, see your Torrington representative or write: **The Torrington Company, Limited, 925 Millwood Road, Toronto 17, Ont., Canada.**

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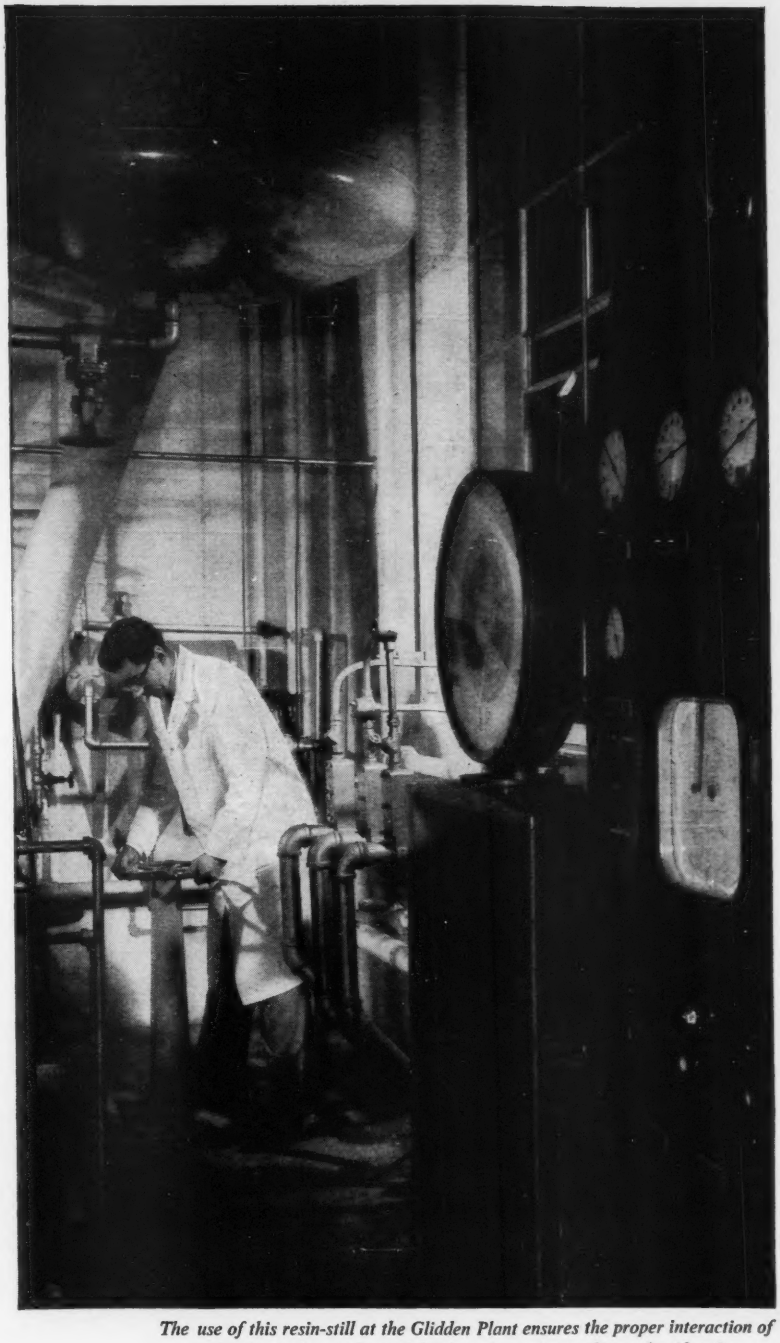
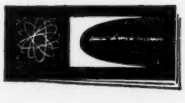


The use of this resin-still at the Glidden Plant ensures the proper interaction of molecules to form industrial finishes of superior quality and uniformity.



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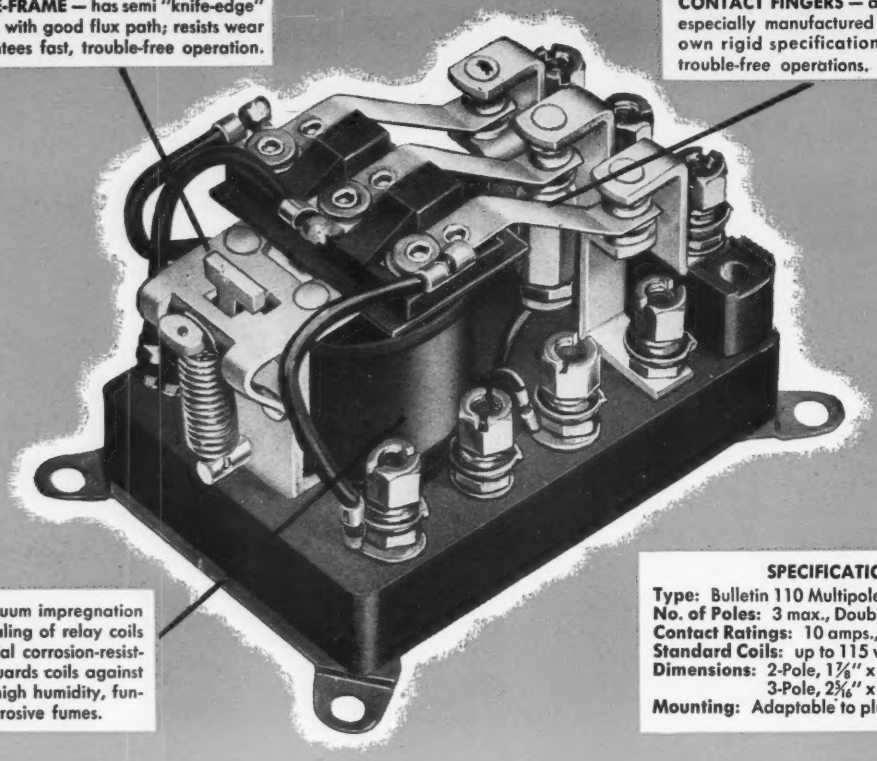
CONTACT FINGERS — alloy leaf-spring type especially manufactured to Ward Leonard's own rigid specifications gives millions of trouble-free operations.



COIL — vacuum impregnation and end sealing of relay coils plus a special corrosion-resistant finish guards coils against salt spray, high humidity, fungus and corrosive fumes.

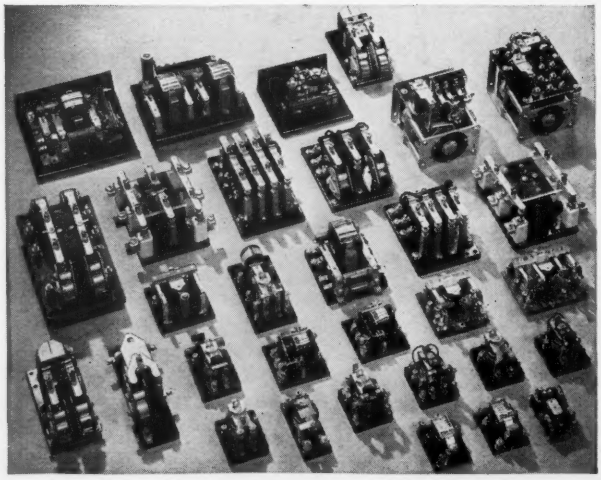
SPECIFICATIONS

Type: Bulletin 110 Multipole Midget
No. of Poles: 3 max., Double Throw
Contact Ratings: 10 amps., 115 volts, A.C. max.
Standard Coils: up to 115 volts, A.C. or D.C.
Dimensions: 2-Pole, 1⅞" x 3" x 1⅞" high
3-Pole, 2⅝" x 3⅝" x 1⅞" high
Mounting: Adaptable to plug-in mounting

Here's why you get long life from Ward Leonard relays

• When applied properly and given normal care, Bulletin 110 relays, shown above, have a life expectancy of several million operations. Such exceptionally long life, typical of Ward Leonard's relay line, is made possible by: 1. Good mechanical design. 2. Quality-controlled manufacturing methods and materials. 3. Ample "safety-factor" electrically and mechanically.

Whether your product is a complex electronic instrument or a simple household gadget, our engineers will be glad to help you select the dependable electrical controls you need. Write Ward Leonard of Canada Ltd., 1070 Birchmount Rd., Toronto 16.



SHOWN AT RIGHT are typical Ward Leonard relays designed to meet your specific requirements in dimensions, methods of mounting, circuit connections, contact materials, coils and other features.

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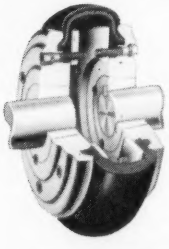
Flexible cushion coupling

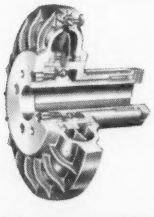
Known as the Para-flex Flexible Cushion Coupling this unit will take angular misalignment, parallel misalignment and end float—singly or simultaneously. In addition, it cushions shock loads, diminishes torsional vibration. Each Para-flex Coupling consists of two hubs and a flexing member greatly resembling a rubber tire. Both hubs are machined to take Taperlock Sprockets, permitting easy application to shafts of different diameter, without reboring. Para-flex Couplings are available to handle up to 700 horsepower in bore ranges from 4½" maximum, down.



No. 101

Dry fluid drive

The Flexidyne Dry Fluid Drive employs a new principle to provide a better solution to many drive problems. The "fluid" in the Flexidyne is a measured charge of steel shot which is contained in a housing —keyed to the shaft. When the motor is started centrifugal force throws the charge to the perimeter of the housing packing it between the housing and the rotor which transmits power to the load. This means that starting is gradual, with



No. 102

initial slippage, which protects the motor and equipment and allows smaller motors to be used. Once full load speed is attained there is no slippage and drive is 100% positive.

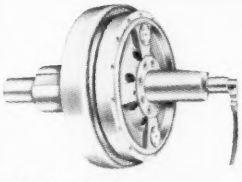
However if overload occurs (determined by the amount of shot in the charge) the Flexidyne will slip, tripping a thermal switch and shutting off the equipment. Flexidyne units are available in sizes to handle up to 75 horsepower, either as drives or couplings.

No. 103

Shaft-mounted speed reducers

The Torque-Arm Reducer is mounted directly on the drive shaft, **eliminating the need for** (1) a flexible coupling, (2) a belt take-up, (3) a reducer foundation. The Torque-Arm has a fixed ratio of reduction and is combined with a V-belt drive; depending on the sizes of the sheaves used, a wide choice of output speeds is possible. A Torque-Arm anchors the reducer and provides easy adjustment of the V-Belts through the use of a turnbuckle. The simplicity, ruggedness and light weight of this unit make it extremely easy to install. Just slip the reducer over the shaft, lock it in place, add oil, line up the sheaves, anchor and adjust the torque arm and the unit is ready to run.

This unit is available in sizes to handle up to 100 H.P. In most cases the Torque-Arm offers very substantial savings over conventional speed reducers.



No. 104

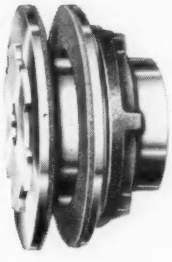
Air grip clutches

Here is an air clutch in which are embodied several unique features with a quick appeal to the operator. Because minimum air is required to operate the clutch the operator gets instant response to the control. The result is maximum sensitivity with finger-tip control and an ability to "inch" the clutch, or throw it into full engagement, as required.

The Air Seal Disc is located out of contact with the heat generating plates. This, together with internal ventilation, makes for cooler operation and longer life. Quick release valves can be supplied as optional equipment and provision is made for mechanical engagement in case of air supply failure. The Air Grip Clutch can be supplied in sizes to handle up to 5000 H.P.

Torque Limiter

The Torque Limiter consists of a driving or driven member in combination with a spring loaded friction mechanism which may be adjusted to slip when the desired torque is exceeded. The unit is compact, easily adjusted and tamperproof. It can be used in conjunction with any rotating member, such as sprockets, gears or pulleys. The Torque Limiter can be supplied to handle up to 620 ft. pounds of Torque.



No. 105

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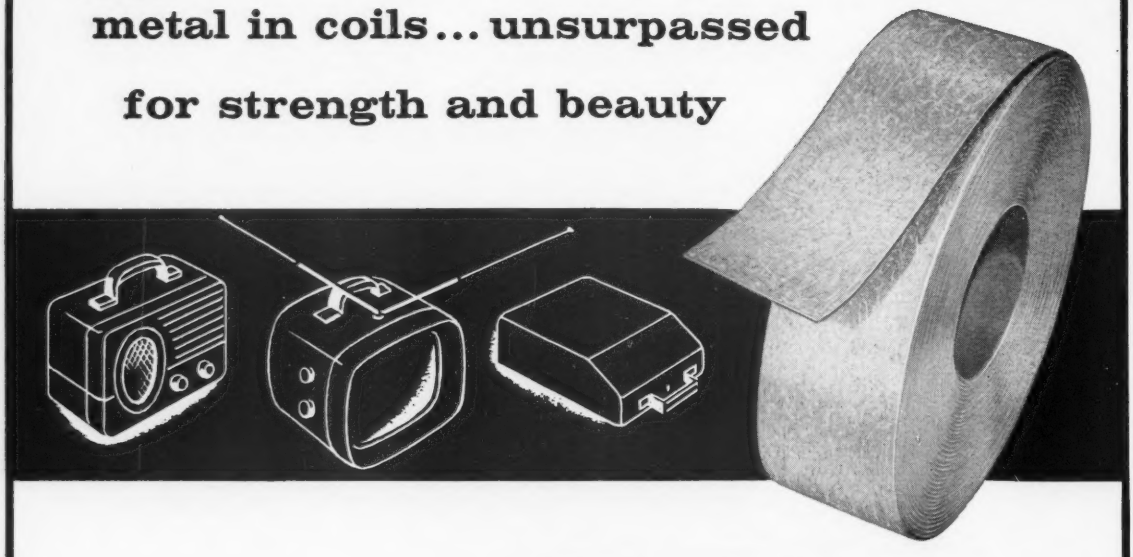

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Smooth, instant change of speed by simple manual adjustment or by remote control devices, either manual or power operated.

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Coaxial input and output shafts, rotating in same direction, either clock-wise or counter clock-wise.

Ample bearing support for both input and output shafts to carry overhung pulleys.

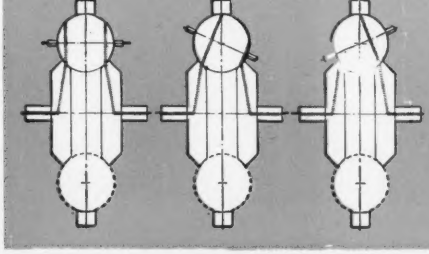
Compact and inherently quiet and smooth running, due to simple construction.

Minimum maintenance and long life, due to absence of belts and other complicated linkage.

Performance proved by prolonged tests in the laboratory and field operation.

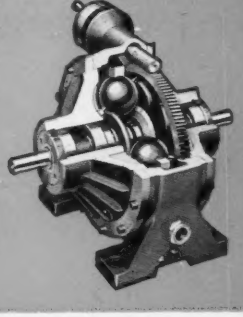
These are the outstanding advantages of the Cleveland Speed Variator. It is now ready for service. Immediately applicable to a wide variety of machines and equipment where a dependable variable speed drive is required. For detailed description and specifications, write for Bulletin K-200.

HOW THE CLEVELAND SPEED VARIATOR WORKS



Power is transmitted from input shaft to output shaft through alloy steel driving balls which are in pressure contact with discs attached to the two shafts.

Relative speeds of the shafts are adjusted by changing the positioning of axles on which the balls rotate (see diagrams, left, and cutaway view, right).



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now available in brass, steel and stainless steel

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the most important advance in tube fittings in 20 years

- No flaring or threading
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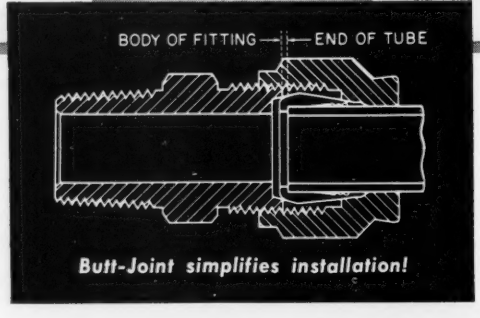
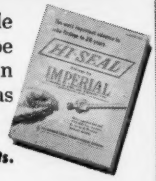
Tremendous popularity of steel and stainless steel Hi-Seal fittings has led many users to request Hi-Seal fittings in brass. You wanted them—Imperial made them — new brass Hi-Seal fittings . . . plus steel and stainless steel fittings so you can profit from famous Hi-Seal advantages . . . like butt-joint, close bends, quick assembly in the metal best suited to each application.

Tube doesn't enter the body of the fitting. It bottoms on shoulder of the sleeve. Camming action of the nut causes sleeve to form a collet-type triple-seal grip on the tubing.



Butt-Joint simplifies installation!

Final circumferential seal is made by tapered edge of sleeve. No tube torqueing when making a joint. Can be disconnected and reconnected as often as desired.



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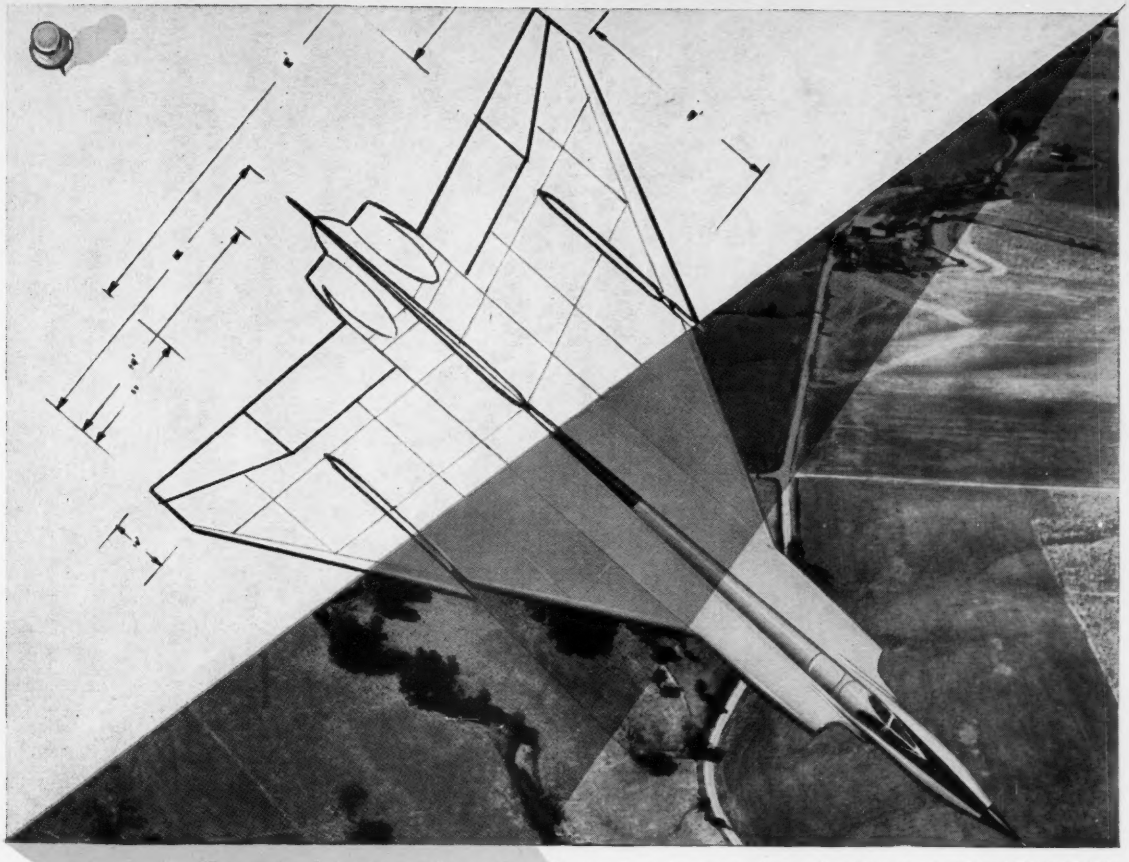

The complex electrical generating system of the new Avro Arrow was designed and developed at LUCAS-ROTAX.

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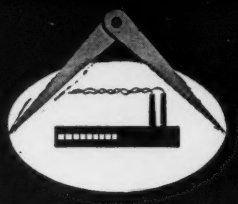


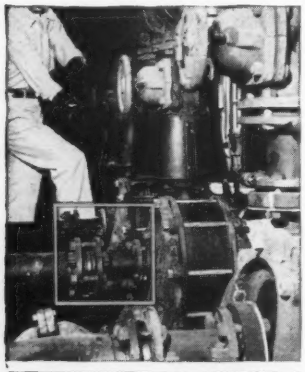
in Industry

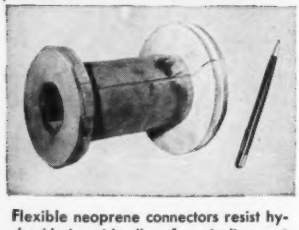
NEOPRENE connectors save $1,000 a year in hydrochloric acid area

At a large midwestern chemical plant, long-lasting neoprene connectors have replaced the original fittings used to connect Karbate pumps to suction and discharge lines. This switch represents a saving in materials and labor of $1,000 a year.

Although the previous materials used were chemically suitable to handle hydrochloric acid, they were rigid, and pump vibrations cracked them. Resilient neoprene connectors are unimpaired by exposure to hydrochloric acid and they are flexible enough to resist vibration to compensate for shifting lines without being damaged.

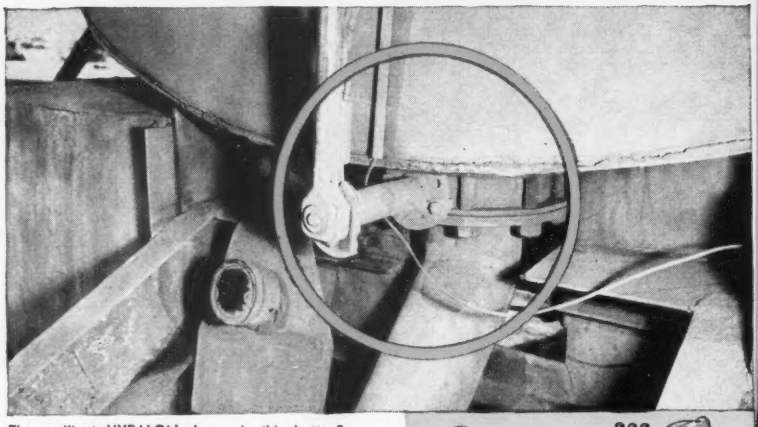
Neoprene resists oil, grease, heat, weather and chemicals and operates successfully under many of the industry's toughest exposure conditions. Mail the coupon for more information. Include your specific problems.



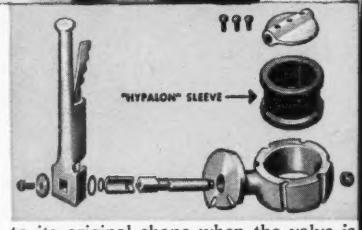


Flexible neoprene connectors resist hydrochloric acid, allow for misalignment between pumps and suction and discharge lines.

HYPALON® eliminates sleeve maintenance costs in butterfly valve handling spent acids



The resilient HYPALON sleeve in this butterfly valve snaps into the ring piece. It acts as both a valve seat and as the gasket between the ring piece and mounting flanges, giving a perfect seal.



ORIGINAL VALVES STILL ON DUTY AFTER TWO YEARS' SERVICE

Industrial Wastes, Inc., of Beaver Falls, Pa., hauls about 2½ million gallons of spent acids each month in its fleet of tank trucks. About two years ago, the company faced the problem of finding an all-purpose tank outlet valve which would give longer service.

They tried a butterfly valve with a sleeve of HYPALON. Here's how it works: An acid-resistant metal damper rotates in a ring piece lined with a HYPALON sleeve. As the valve closes, the metal disk distorts the resilient HYPALON sleeve to form a pressure-tight seal. The sleeve returns to its original shape when the valve is opened.

The resistance of HYPALON to sulfuric, nitric, hydrochloric and hydrofluoric acids has kept the valve in operation for *two years*—with a minimum of maintenance. Can HYPALON help you? This versatile synthetic rubber also has unusual resistance to hardening at elevated temperatures (250° to 350°F.)... is virtually ozone-proof . . . and can be fabricated into hose, gaskets, belts, linings or prepared as solution coatings. For more information, clip and mail coupon.

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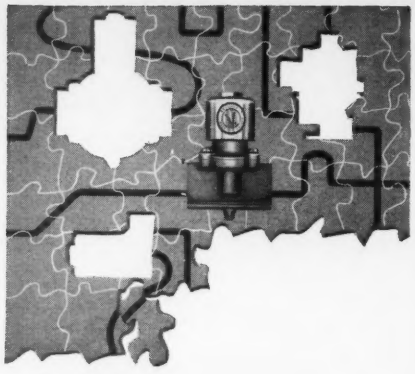

SKINNER'S NEW 2-WAY VALVE OFFERS

big capacity — high pressure

Here's the second new line of valves designed to answer your control "puzzles." This new line, called the R Series, is a two-way, pilot-operated piston valve with ¼" orifice and ¼" NPT. It is available normally open or normally closed and operates on a pressure differential of 5 to 200 PSI. This new R Series also includes an Explosionproof line in normally open and normally closed construction. A normally closed version will be available soon to operate on pressures up to 1000 PSI.

This new R Series uses the famous Skinner V5 Operator and will control air, water, oil and semi-corrosive media. The normally open version can, on request, be supplied with pilot exhaust piped to body outlet port.

A wide selection of coils—high-temperature, waterproof and standard—for common AC and DC voltages is available, and there is choice of electrical connections such as Automotive Terminals, Grommet and Conduit.

The temperature range of this new line is −65° to 180°F Ambient, and −65° to 150°F Media. It is light in weight—only 1¼ pounds—and can be mounted directly to the line by means of the ¼" NPT. Distance between ports is 2 inches.

For complete information about this new line of Skinner valves, please contact our Representative or Distributor near you—you'll find him listed in the Yellow Pages. Or write us at the address below, Dept. 355.

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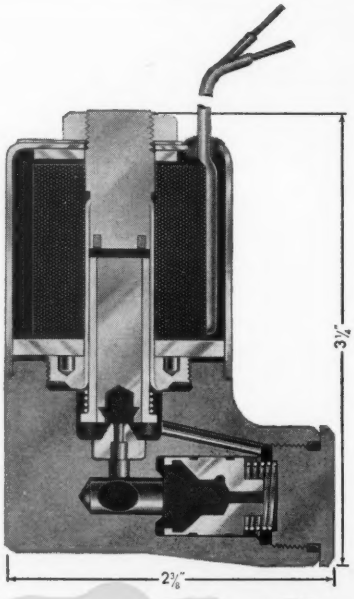
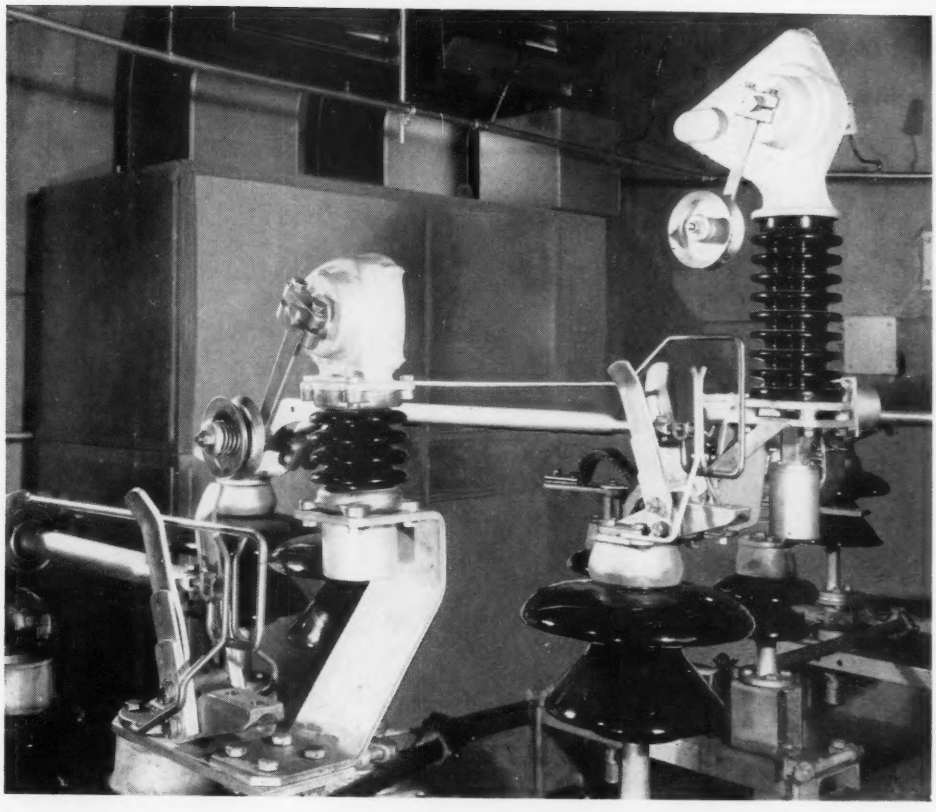


SKINNER ELECTRIC VALVES

THE CREST OF QUALITY

SKINNER ELECTRIC VALVE DIVISION
NEW BRITAIN CONNECTICUT
105 EDGEWOOD AVENUE



Device that damps dangerous arcs

This will open and close a live circuit in complete safety

One difficult problem in power switching is the safe interruption of light load currents, charging and magnetizing currents. Above 600 amps, these currents are interrupted by means of circuit breakers, but cost prohibits the use of breakers for lesser values. Without some device on standard disconnect switches, long and sometimes dangerous arcs are drawn between switch contacts and blades. These arcs can endanger the entire distribution system by flashing either between phases or to ground.

Many different types of interrupting device are used to solve this problem, each designed for specific requirements. Some swiftly elongate the arc and extinguish it in the open air; others draw it into an enclosure where gases smother it. Recently, Delta-Star Electric Division of H. K. Porter Company Limited announced a new interrupting device, the Powerupter. It is designed to open, or close, a live circuit, in perfect safety.

This compact device (it can be used on any type of Delta-Star air switch) is capable of interrupting currents up to 600 amps. Sturdily constructed, it consists of a double-action tripping mechanism in a weatherproof metal housing. The housing is mounted on a porcelain tube with an interrupting chamber inside and a metal enclosed exhaust chamber mounted to the bottom of the tube.

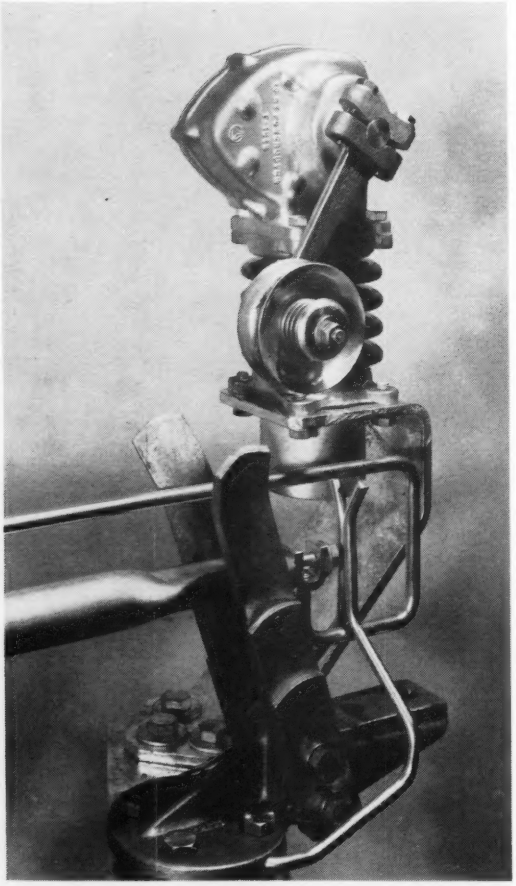
From the tripping mechanism, an operating

arm extends outside the metal housing to a position just above the switch contact, in the path of the blade. The Powerupter's tripping mechanism is attached to the upper end of a plunger with a movable contact, inside the interrupting chamber. The movable contact is on the lower end of the plunger and operates up and down, and a stationary contact is mounted on a tube which extends down into the exhaust chamber. When closed, these contacts are forced together.

With the switch in the closed position, no current is flowing through the Powerupter. As the switch blade leaves the contact in opening, it bears against a copper rod (or arcing horn) extending above the contact. The blade touches the arm just before leaving the arcing horn and the current flows through the Powerupter. As the switch blade raises the arm, the arm winds a spring in the tripping mechanism. When the arm is raised to a certain point, the mechanism trips, drawing the movable contact on the plunger swiftly up through the interrupting chamber, away from the stationary contact. This instantly interrupts the current flow and the resultant arc is immediately quenched by gases evolved from the materials from which the plunger and the lining of the chamber are made.

Gases released from the interrupting chamber are confined and cooled in the exhaust chamber. The arm remains in the uplifted position after the switch blade parts with it to open fully. When the switch blade is closed, it pulls the arm down to its original position and the tripping mechanism (operating in reverse) allows closing into the live circuit without danger of arcing. Because the movable and stationary contacts may be burned slightly with each operation, a creeper spring re-positions the points of contact after the completion of an opening and closing cycle.

The device has been thoroughly tested, both electrically and mechanically. Positive operation in opening and closing (under all weather conditions) is assured and the unit is designed and constructed to give long lasting, trouble-free service. ★



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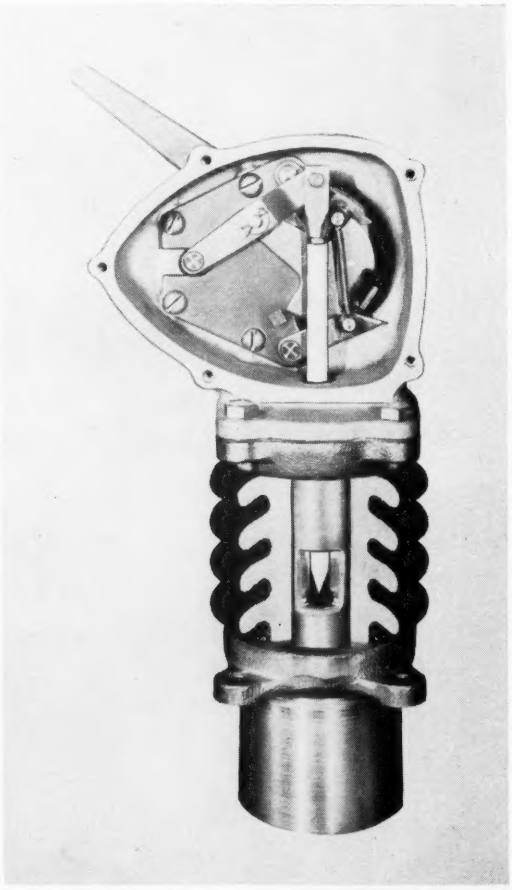

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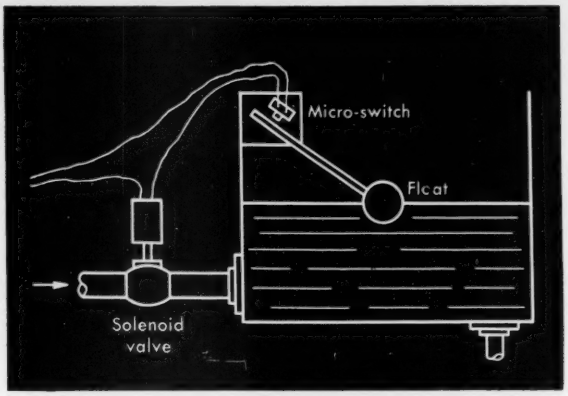

1

Short course in liquid level controls

Limitations in the basic float and valve have boosted developments

D. H. Bamford MEASUREMENT ENGINEERING LTD.

Probably the most common application of liquid-level controls is the mechanical linkage connecting float and valve, as found in the carburetors of our cars, outboard motors and oil stoves.

In its simplest form, the float rises with the liquid level and, through a simple linkage, controls a valve as it reaches a predetermined point. Modifications of this system are in use in many industrial applications and, because of their simplicity, will undoubtedly continue to be used. The inherent limitations leave room, however, for other techniques.

The complications caused by liquids that are highly corrosive, have high viscosity, are highly volatile or require extremes of sanitary cleanliness, are only a few of the problems that are met.

Modern industrial processes require increasingly higher accuracy as well, and frequently involve high temperature and pressure, slurries (containing solid particles), tilting and overturnings tanks, foam and turbulence, and combinations of these factors. Further, remote indication and recording are frequently required.

Mechanical devices for the control of solenoid valves (or the remote indication of a predetermined level) still use the float, so arranged as to operate one or more micro-switches or mercury-tilt switches (see Fig 1).

In another modification using the float, it is permanently connected to a ferrous rod and so arranged that both move up and down vertically, in an open-ended cylinder (Fig 2).

Near the top is arranged a pivoted arm carrying a small (but strong) permanent magnet and a mercury-tilt switch.

As the float rises it enters the field of the magnet, which is attracted to it. As it moves, it operates the mercury switch, which in turn operates a valve controlling the flow of liquid.

In another (this is not shown), the float and lever are coupled to a dial indicator by a simple linkage, and give a direct reading of liquid level on the outside of the tank.

Pneumatic principles also are used for liquid level gauging, as shown in Fig 6. Compressed air is supplied through a filter, regulator, choke valve and a visible glass sight bubbler to the fitting at the top of the air chamber.

When the liquid begins to fill the tank, pressure builds up in the air chamber until this pressure equals the pressure of the source of constant air supply. This pressure is an indication of the liquid level.

The pressure acts through the return line on the bellows head and the motion of the bellows is transmitted by linkage (and a sector-and-gear) to the indicator pointer.

Any excess pressure passes up through the liquid to the atmosphere through the vent.

Several versions of this basic principle are available. One interesting modification is used for indicating the level of molten glass in a glass tank furnace. A tube, through which flows a constant air supply, is lowered near the surface of the material to be controlled. Very low pressures and small currents of air flow within the sensing tube. As the liquid level approaches the tube, a restriction of the flow of air is created, causing a back pressure within the sensing tube. The variation of back pressure (due to the rise and fall of glass level) is magnified by the use of a differential pressure controller with an amplifying stage. This permits control of the level to an extremely fine degree.

A **thermal liquid level switch** has recently been put

on the market. It eliminates short cycling, by providing automatic damping.

The thermal instrument operates on a difference in heat transfer between the sensitive element and the liquid in the vessel (or the sensitive element and the vapor), and not on the difference in temperature or latent heat. The operating mechanism consists of two thermal elements of the rod and tube pattern, located in the tank at the critical level.

An electric heater is wound concentrically with one of the invar rods and is continually energized so that one thermal element is always at a higher temperature than the other.

The second unheated thermal element acts as a compensating device for changes in the general temperature of the vessel in which the level is being controlled.

When the two thermal elements are surrounded by vapor, the temperature difference between them will be that caused by the heater around one thermal element, less the heat loss to the surrounding vapor. Over these conditions the instrument is stable and the switch has not operated.

When the liquid level rises so as to come in contact with the two thermal elements, the rate of heat loss from the heated element increases rapidly, thus reducing the difference in temperature between the two thermal elements and causing the switch to operate. Because of the thermal inertia of the instrument, it has some advantages in applications involving turbulent liquids or foam.

Various **electronic principles** are used for sensing the levels of liquids. These commonly take the form of a probe that may be permanently mounted for indicating when the liquid is at a predetermined level, or may be connected through a servo-system to indicate (locally or remotely) the actual liquid level.

These probes use resistive, capacitive, ultrasonic, thermal or nuclear sensing. Resistive sensing probes are probably the most common; they are suitable for many applications in the chemical, food processing and dairy industries (Fig 3).

In its simplest form, the liquid is used to complete an electrical circuit connecting a source of power to a relay. The relay contacts then operate a solenoid valve which controls the flow of liquid. As this requires considerable current, it is only suitable for liquids of low resistivity. The sensitivity may be increased tremendously, however, by using an electronic amplifier between the probe and the relay coil. Further, use of a thyratron and a mercury plunger relay permits a current through the liquid of a few microamperes to control up to 60 amps and operate not only valves, but motors and pumps.

The capacitive sensing probe is suitable for most liquids, for finely granulated semisolids of the type that flow (such as sugar or dry sand) and also for interfaces, such as those between water and oil. The probe may consist of an insulated metal rod, which forms one "plate" of a capacitor. The other "plate" may be the fluid or another similar rod, or even a cylinder surrounding the rod (Fig 4).

A rise in level of the liquid increases the capacity in the circuit, which is usually part of an oscillator or a biased bridge. Radio frequencies are usually employed. A modification of this control has a meter calibrated in units of height: it may be connected into a recorder.

Ultrasonic principles are being used for liquid level gauging. One special application is to determine the presence (or absence) of liquids at a predetermined level in tanks of aircraft or missiles. It uses extremely little power in the probe, and so there is no danger of its igniting gasoline fumes. An ultrasonic transducer in contact with the liquid presents a terminal impedance appreciably different from that obtained when it is "air-loaded." This principle is useful for almost any liquid or semisolid and has an accuracy of $\pm 1/32$ in. It is instantaneous in operation, requires no correction charts and can be completely sealed in stainless steel, so that it will not contaminate foods or beverages.

Still another application of ultrasonics uses the same principles as are employed in sonar depth sounding.

A pulse of sound originating from a transducer at the top of the tank is reflected from the liquid level and bounces back to a receiving transducer. The associated circuits measure the time that has elapsed between transmitting and receiving the sound pulse and convert this to a reading on a meter (calibrated in ft) that indicates the distance between the top of the tank and the liquid level. Since zero reflection time corresponds to a full tank, the meter reads backwards, and it is necessary to take the tank height into consideration during calibrating.

Another approach to the problem of fuel level measurement in aircraft and missiles uses the characteristics of a **thermistor** as a sensing element (Fig 5).

The thermistor is a resistor having a high negative temperature coefficient of resistance. In other words, the resistance decreases markedly with an increase in temperature. If appreciable current flows through the thermistor, the heat developed by the I^2R losses within the thermistor tends to raise its temperature above that of the surrounding air or liquid.

In air, the rate of heat transfer from the thermistor is low. Its temperature will therefore be relatively high.

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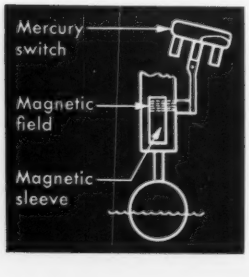

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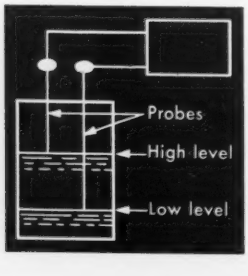

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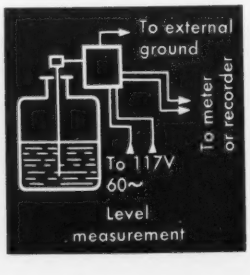

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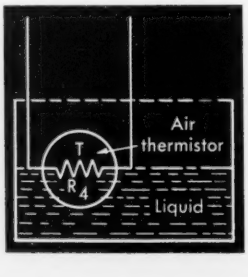

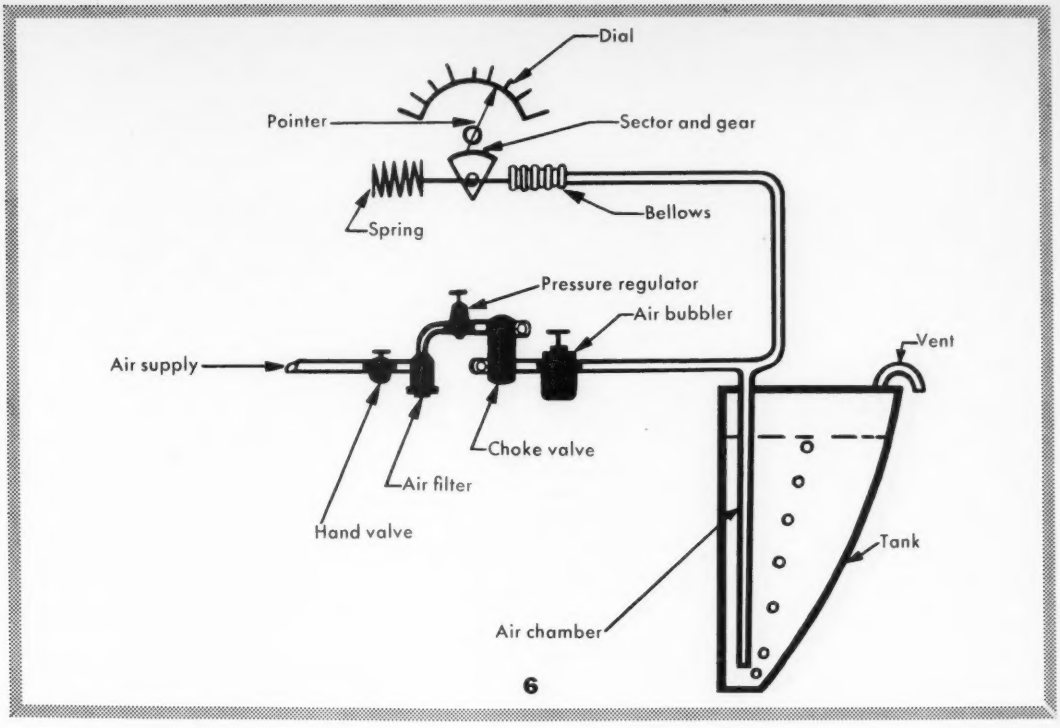

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In a liquid, the rate of heat transfer is high, and so the temperature of the thermistor will be relatively low. The resistance of the thermistor will thus be considerably higher when immersed in a liquid than when in air.

The thermistor bead is mounted at the end of a probe arranged to indicate the presence (or absence) of fluid at a predetermined height. It is connected in one arm of a d-c resistance bridge, balanced with the liquid absent. The null detector of the bridge is replaced by a sensitive relay. Unbalance of the bridge, caused by a lowering of the thermistor temperature, operates the relay.

The bridge could be operated from an a-c rather than d-c source, if a suitable relay were employed. Although the thermistor operates much above the surrounding air temperature (when out of the fluid), tests show that it is safe, even for highly ignitable aviation fuel. The accuracy is approximately ± 0.1 in.

Nuclear principles have been adapted to liquid level gauging in several ways. Probably the simplest of these methods consists of a radioactive source, a geiger tube and an indicator.

Fig 7 shows a portable level indicator requiring two men, working on opposite sides of the tank, to move the source and detector up and down in unison. As the fluid absorbs the radiation, the level may easily be detected. The same equipment may be fastened mechanically to the tank and synchronized to move in the same direction at the same speed, or permanently fastened to the tank as an indication of the presence or absence of the liquid (Fig 8).

By using several sources of radioactive material, an indication of level (rather than merely presence of absence) may be obtained. The sources may be mounted in a well within the tank or in separate holders inside or outside the tank.

One method uses a radioactive source and a detector, both mounted on cables inside separate sealed wells inside the tank. The source and detector are raised or lowered in synchronism and a servo-system automatically indicates the level at a remote point (Fig 9).

Gamma ray radiation from radioactive cobalt is being used by Westinghouse Research Laboratories to control the height of a titanium ingot being melted in an arc furnace.

A small needle of cobalt 60 is placed outside the

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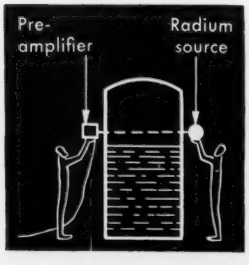

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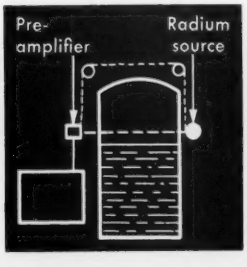

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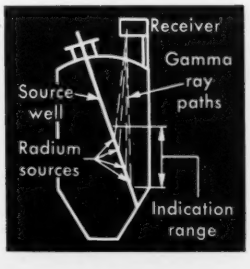

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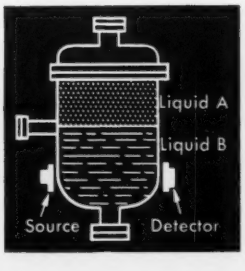


furnace, and in line with the desired position of the surface of the ingot within the furnace. A shielded lead box, having walls about 4 in. thick, contains the cobalt 60. When a shutter in the box is opened, gamma rays pass through the furnace walls and across the top of the surface of the ingot. If the ingot is too high, it partly blocks the gamma rays, reducing the amount of radiation received on the other side of the furnace. If the ingot is too low, the amount of radiation passing through the furnace is greater.

The radiation is detected by two counters containing a crystal which changes the gamma rays into flashes of light. The equipment then converts the light flashes into electric pulses and amplifies them. The amplified pulses are fed to electronic circuits which drive a hydraulic system that raises or lowers the titanium ingot to the exact position required for proper operation of the arc furnace. The system can detect and maintain the position of the ingot to within 0.01 in. of its ideal operating position.

Radioactive material is used as the sensing element of a liquid level switch that has been placed on the market by the aeronautical division of Robertshaw Fulton Controls Co. The unit is primarily designed to meet the needs of the aircraft industry for a fuel level control device that will perform reliably and accurately under extremes of temperatures, vibration and shock.

The liquid level switch consists of a pencil-size sensing probe (containing a hermetically sealed beta source and a beta detector) mounted inside the fuel container. The beta source and detector are separated by a small cavity, into which liquid may flow.

When no liquid is present, radioactive particles pass from the beta source to the detector tube, but when liquid enters the cavity, it absorbs the particles and thus reduces the radiation level at the detector. The variation in radiation is converted to an electrical signal, which is amplified by a transistorized circuit to actuate a relay. The relay is used to switch on warning lamps, valves or servo-motors according to some prearranged system.

Of course, the electronic level indicators described are adaptable for monitoring any number of containers. The signals from several sensors may be switched to a common multi-pen recorder, to give a continuous record of the level in different containers.

Photocells have been applied to the problem of level gauging on boilers, by having a beam of light shine through the sight tube. The rising water cuts the beam and its shadow operates the photocell.

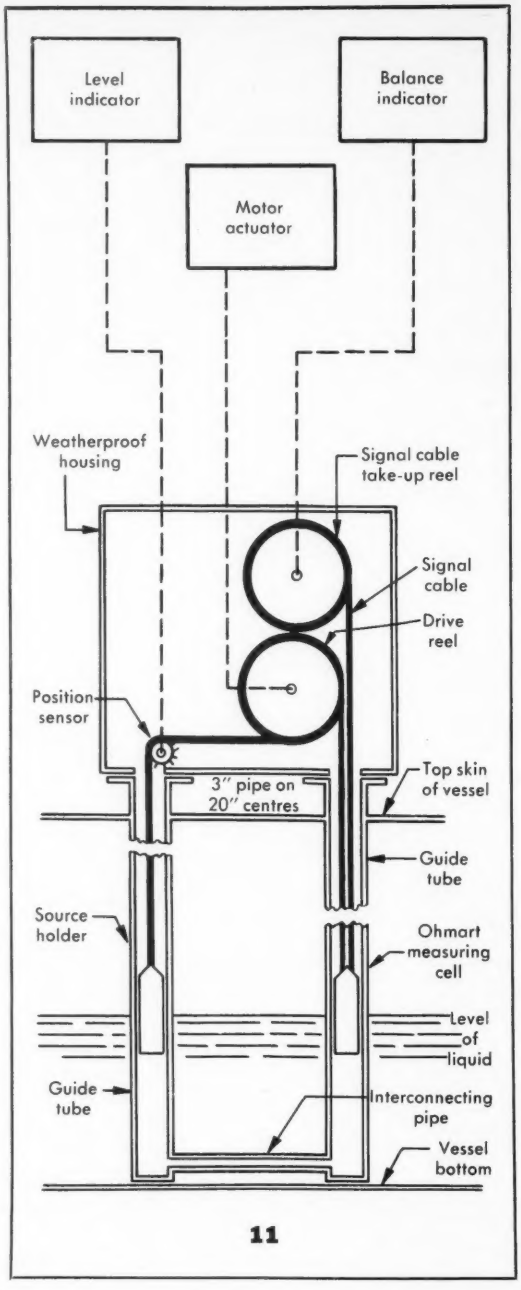
The differential pressure gauge is readily adapted to liquid level control but does not approach the accuracy of the level sensing methods.

Almost all the sensing probes described can be used for continuously indicating level, by connecting to a motor-controlled cable, feed-back loop and servo-system and, of course, to a recorder (Fig 11).

The resistive, capacitive and nuclear sensors are quite commonly used in this way.

The examples cited are representative of modern methods of level control and indication. Undoubtedly other modern methods will appear, but the earlier (mechanical) methods will continue to be used, for in many cases they are still quite suitable and sometimes less expensive.

Modern production methods require greater accuracy of instrumentation and control of parameters than formerly. As this trend continues, refinements of even these modern gauging methods will be required. There are, however, very few problems that cannot be solved by the application of the principles described. ★



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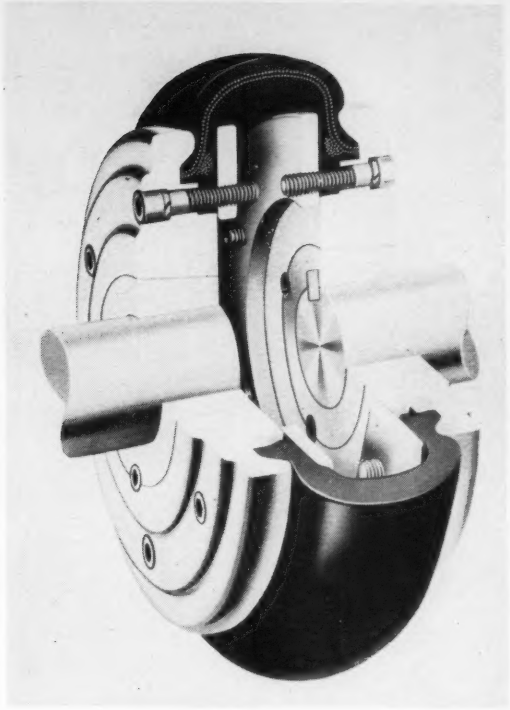


Simplicity gives a coupling dependability

Simple rubber tire lets a coupling handle misalignment and end float

The ability to handle angular misalignment, parallel misalignment and end-float is one of the many advantages claimed for the Dodge Para-flex coupling. The flexible member also cushions shock loads and diminishes torsional vibration, thus protecting both the driver and the driven machine.

Developed in West Germany, the coupling has already been proved in thousands of installations there. United Steel Corporation have adapted the new development to the standards of Canadian industry. It is available in capacities up to 600 hp at 900 rpm.

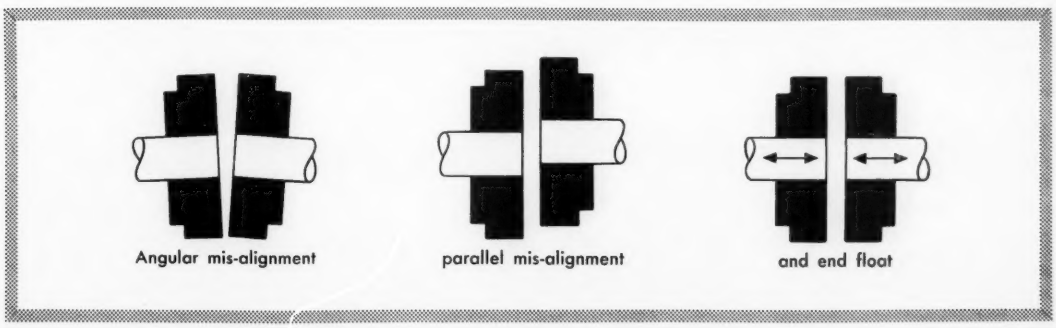
The heart of the coupling is a tire with synthetic tension members bonded together in rubber. The coupling has, in fact, been made possible by the technological advances in the manufacture of modern automobile and truck tires, engineered to carry tremendous shock loads at high speed.

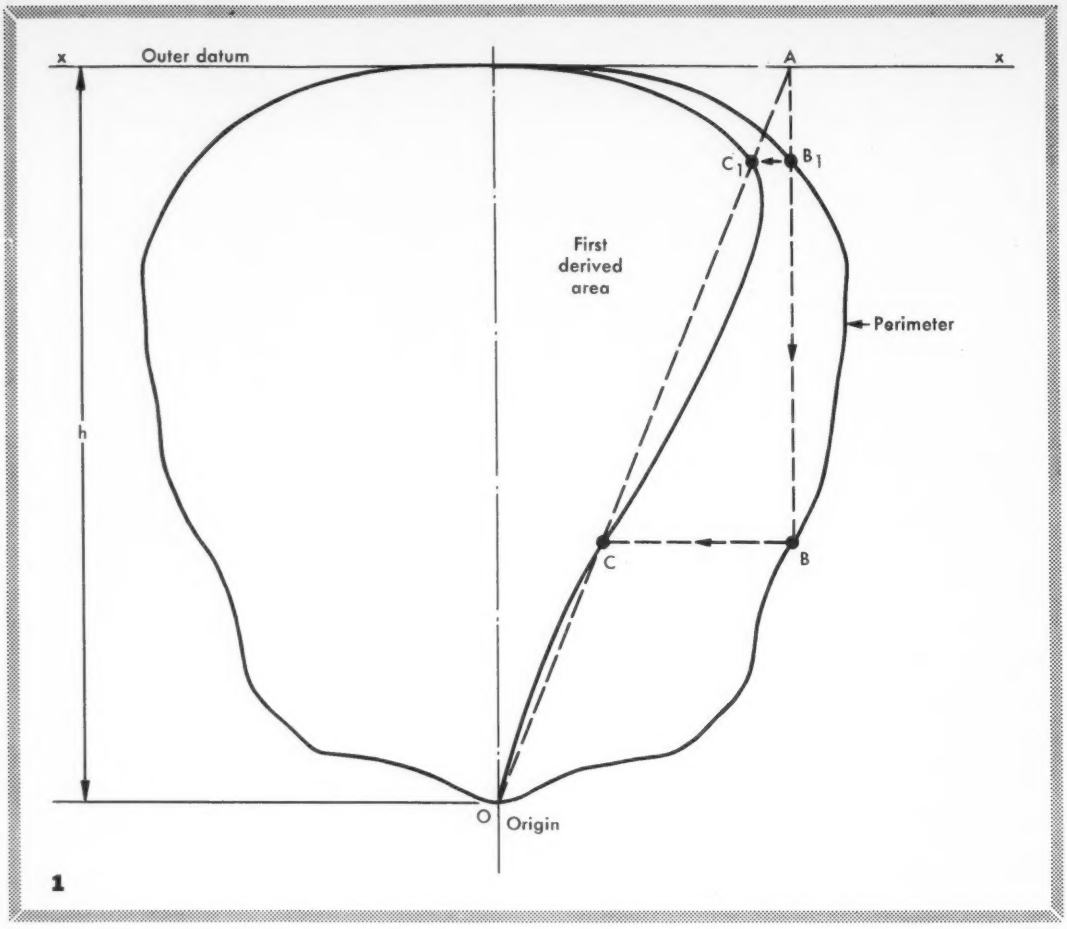
In addition to its many operational advantages, Para-flex has other highly desirable features of installation and maintenance. Like most great advances in engineering design, it is essentially simple and this simplicity contributes to its dependability.

How it works: The coupling consists of the flexible tire clamped between two hubs mounted on the shafts to be coupled. The flexible member is held between the flanges and clamp ridges of the hubs.

Both hubs of the coupling are machined to take Taper-Lock bushings. These give the equivalent of a shrink-on fit on the shaft and permit quick and easy application to shafts of different diameters, without reboring.

The tire has a transverse split woven into it, to permit easy installation and make replacement possible without moving driver or driven machine. To make a change, it is only necessary to loosen the cap screws enough to allow removal of the tire and to fit a new one in place. Even in very confined spaces, this simple operation can be accomplished in a few minutes. ★





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Some new light shed on derived areas

Investigation by the author leads to elimination of some confusion

W. H. Sheppard

Fig. 1 shows the method of constructing the derived area for a simple figure. Draw a straight line from the origin O to meet the outer datum xx at A. Construct the perpendicular AB to cut the perimeter at B_1 and B and drop perpendiculars B_1C_1 and BC to OA. Repeat for a series of points which are joined to give the first derived area (shown shaded). This may be repeated to give successive derived areas.

Fig. 2 shows the construction for a semi-circle, a figure chosen for a series of examples to enable mathematical checks to be made. Actual areas may be measured by any recognized method. (planimeter, Simpson's rule, counting squares) the last named being used in the examples that follow.

DERIVED AREAS

Text books and reference works often display **derived areas** for obtaining centres of area, and sometimes second derived areas for finding the moment of inertia of beam sections and the like. Little regard seems to be given, however, to the most accurate way of positioning these areas or of special points to watch in geometric construction. Also, it is not generally realized that a third derived area may be used to determine the moment of inertia of a volume of revolution (e.g., a flywheel). To clarify these points, a thorough investigation was carried out by the author and some of the results are given here. To avoid confusion, actual distances (such as x and k) are referred to when possible. Where moments of inertia are used, these are the second moments of area or volume so that those of mass or weight may be deduced therefrom, according to the units used.

In some popular reference books greater accuracy is claimed for beam sections (and the like) by taking floating centres (or origin) and sidestepping the first area up against one side of the original. This is quite unnecessary and even less accurate. For a symmetrical figure it is only necessary to draw one half; for asymmetrical figures it is preferable to side-step up against one perpendicular to give a figure as in Fig. 1. It should be noted, however, that if a half-figure is used to determine the moment of inertia, the result must be doubled to give the full value.

Full area. Mean height (H) is given by:—

$$H = A/l \quad \text{where} \quad l = \text{length of base}$$

EXAMPLE. (Fig. 2, Semi-circle). Note that ½ areas are drawn but full areas are considered.

$$A = 39.8, \quad l = 10, \quad d = 5$$

$$H = \frac{39.8}{10} = 3.98 \text{ in.}$$

Mathematically,

$$H = \frac{\pi D^2}{8l} = \frac{\pi \times 100}{8 \times 10} = 3.98 \text{ in.}$$

1st derived area. From geometry of construction of derived area,

$$y^1/y = x/d$$

$$A^1 = \int y^1 \, dx = \frac{1}{d}\int xy \, dx$$

1st Moment of Area $M = \int xy \, dx = A^1 d$

Ht. of Centre of Area

$$\bar{x} = \frac{M}{A} = d\frac{A^1}{A}.$$

It will be realized that, in measuring the first derived area, the result for $\bar{x}$ depends more on the accuracy of one side of the figure than the other and in application to beam sections one boom is practically ignored. To overcome this it is recommended that the first derived area be drawn in two opposite directions. The two areas should add up to the original area.

Alternatively, the origin may be taken at the middle of the figure.

EXAMPLE (Fig. 2, Semi-circle).

From base

$$A_1^1 = 16.6$$

$$\bar{x}_1 = 5.\frac{16.6}{39.8} = 2.12 \text{ in.}$$

Mathematically

$$\bar{x}_1 = \frac{4r}{3\pi} = 2.12 \text{ in.}$$

EXAMPLE. (Fig. 3, Typical Beam Section).

$$d = 16.5 \text{ in.}, \quad A = 33.45 \text{ in.}^2$$

From bottom

$$A_1^1 = 15.33$$

$$\bar{x}_1 = \frac{15.33}{33.45} \times 16.5 = \underline{7.57} \text{ in.}$$

From top

$$A_2^1 = 18.12$$

$$\bar{x}_2 = \frac{18.12}{33.45} \times 16.5 = \underline{8.93} \text{ in.}$$

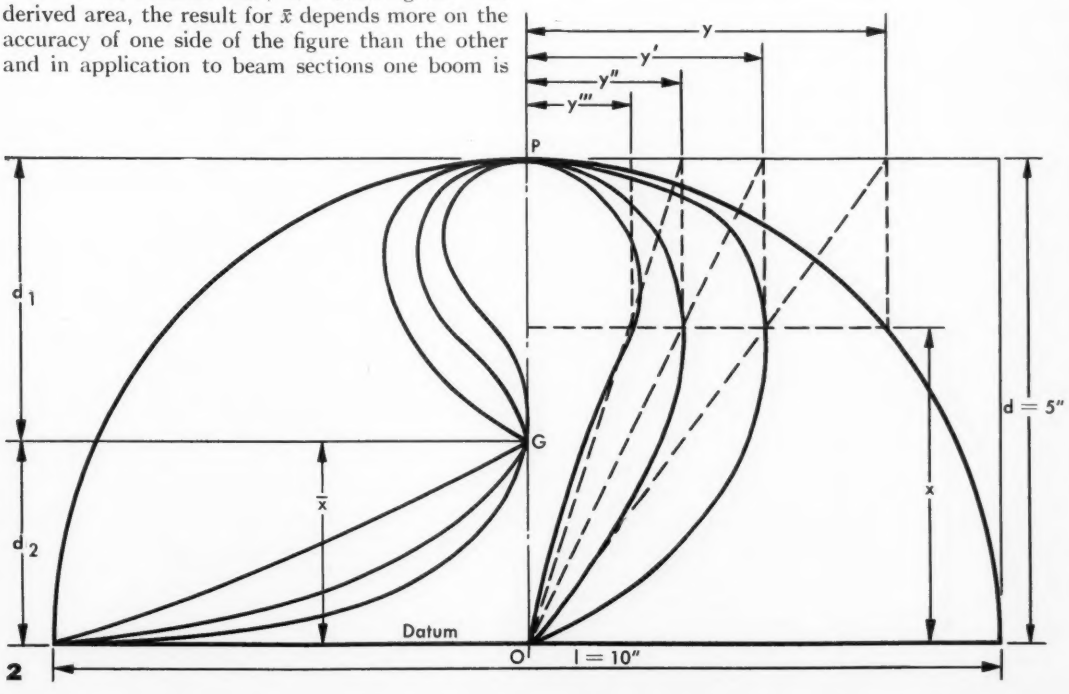
Check.

$$7.57 + 8.93 = 16.5 \text{ in.}$$

Volume of revolution (V)

$$V = 2\pi \int xy \, dx \text{ (about } y \text{ axis)}$$
$$= 2\pi d A^1 \quad \text{or} \quad 2\pi \bar{x} A.$$

If the origin used for the derived areas is on the axis of revolution, it is recommended that the first form



be used, otherwise the second is preferable, written as $2\pi hA$, where h is the distance from the axis to centre of area.

EXAMPLE. (Fig. 2, Semi-circle).

$$A^1 = 16.6 \text{ in.}^2$$

$$V = 2\pi dA^1 = 2\pi \times 5 \times 16.6 = 524 \text{ in.}^3$$

Mathematically,

$$V = \frac{\pi D^3}{6} = \frac{\pi}{6} \times 1000 = 524 \text{ in.}^3$$

Root-mean-square (R)

This may be calculated from the fundamental formula but it is useful to realize that a rectangle of height R and of the same length l as the figure has the same volume of revolution.

Then $\pi R^2 l = 2\pi dA^1$ or $2\pi \bar{x} A$

$$R = \sqrt{\frac{2dA^1}{l}} \quad \text{or} \quad \sqrt{\frac{2\bar{x}A}{l}}$$

EXAMPLE. (Fig. 2, Semi-circle).

$$R = \sqrt{\frac{2 \times 5 \times 16.6}{10}} = 4.08 \text{ in.}$$

Mathematically

$$R = \sqrt{\frac{2 \times 4r \times \pi r^2}{r \,.\, 3\pi \,.\, 4}} = 4.08 \text{ in.}$$

Second derived area (A^{11})

As before, $\frac{y^{11}}{y^1} = \frac{x}{d}$

$$\frac{y^{11}}{y} = \frac{x^2}{d}$$

$$\therefore A^{11} = \int y^{11} dx = \frac{l}{d} \int x^2 y \, dx$$

2nd moment of area

$$I = \int x^2 y dx = d^2 A^{11}$$

Radius of gyration

$$k = \sqrt{\frac{I}{A}} = d\sqrt{\frac{A^{11}}{A}}.$$

To obtain the value of I or k about any other axis, use the parallel axis theorem:—

$$I_y = I_o - A\bar{x}^2$$

more conveniently written as

$$k_a^2 = k_a^2 - \bar{x}^2$$

which may be applied by Pythagoras' theorem. It should be particularly noted that k_a is the radius of gyration about the centre of area.

Any initial datum may be used. Textbooks usually employ the bottom edge of the figure as used to determine the centre of area (with the same disadvantages) or make matters worse by taking a datum outside the figure. Since the value of k_a is usually required, inaccuracies are introduced either in geometric construction or mathematical calculation. By far the best method is to take a new datum through the centre of area. Textbooks sometimes do this but treat the lower portion as a continuation of the top giving a "cross-over" diagram. It is preferable to take each portion separately, care being taken to correct for different values of d if necessary.

EXAMPLE. (Fig. 2, Semi-circle).

$$A^{11} = 9.8$$

$$k = 5\sqrt{\frac{9.8}{39.3}} = 2.5 \text{ in.}$$

Mathematically, $\frac{r}{2} = 2.5$ in.

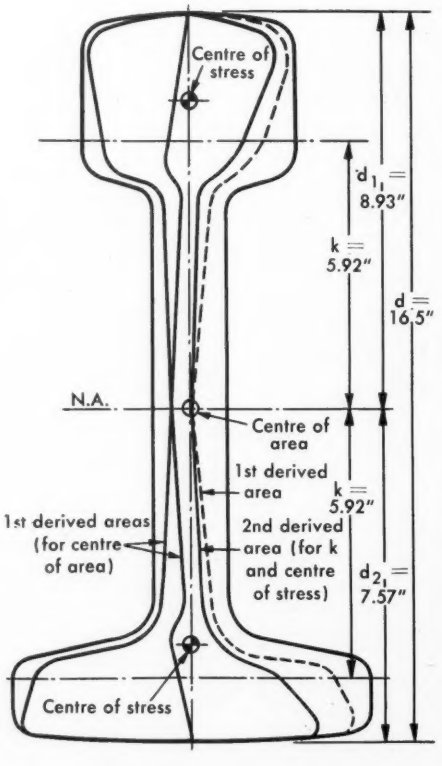
$$A_1^{11} = 2.2, \quad A_2^{11} = 3.5 \equiv 3.5 \times 0.735^2 = 1.9 \Sigma A^{11} = 4.1$$

$$k = 2.88\sqrt{\frac{4.1}{19.5}} = 1.32 \text{ in.}$$

Mathematically

$$k = \sqrt{\left(\frac{r^2}{2}\right) - \bar{x}^2} = \sqrt{2.5^2 - 2.12^2} = 1.32 \text{ in.}$$

BEAM SECTION



3

EXAMPLE. (Fig. 3, Beam section).

As stated previously, it is only necessary to draw one half of a symmetrical figure, but in this article derived areas have been separated to clarify the drawing.

$$I = 8.93^2 \times 14.74 = \underline{1{,}175} \text{ in.}^4$$

$$k = 8.93\sqrt{\frac{14.74}{33.45}} = \underline{5.92} \text{ in.}$$

or

$$k = \sqrt{\frac{I}{A}} = \sqrt{\frac{1{,}175}{33.45}} = 5.92 \text{ in.}$$

Top surface

$$Z_1 = \frac{I}{d_1} \quad \text{or} \quad d_1 \Sigma A_1{}^{11} = \underline{131.5} \text{ in.}^3$$

$$Z_2 = \frac{I}{d_2} \quad \text{or} \quad d_2 \Sigma A_2{}^{11} = \underline{155.2} \text{ in.}^3$$

whence skin stress $f = \dfrac{M}{Z}$

Polar radius of gyration (ρ) Using the perpendicular axis theorem

$$\rho^2 = k_x{}^2 + k_y{}^2$$

ρ is determined from k_x and k_y by Pythagoras' theorem. Note, however, that unlike the parallel axis theorem, this applies only to areas and uniform laminae.

To find:—Depth of centre of pressure of submerged area; Distance of centre of stress from neutral axis; Distance of centre of percussion or centre of oscillation of uniform lamina from suspension as given by the ratio $\dfrac{k^2}{\bar{x}}$.

For direct determination from the derived areas,

$$\frac{k^2}{\bar{x}} = d^2\frac{A^{11}}{A} \div d\frac{A^1}{A}$$

$$= d\frac{A^{11}}{A}$$

that is, at the centre of area of the 1st derived area.

EXAMPLE. (Fig. 2, Semi-circle).

Considering diameter as datum,

$$\frac{k^2}{\bar{x}} = 5.\frac{9.8}{16.6} = 2.95 \text{ in.}$$

Mathematically

$$\frac{k^2}{\bar{x}} = \frac{r^2}{4} \cdot \frac{3\pi}{4} = 2.95 \text{ in.}$$

Centre of pressure

This is the point at which the pressure on a submerged area may be considered to act. Its distance from the water line is given by $\dfrac{k^2}{\bar{x}}$.

This formula may be applied to inclined areas if the distances are measured along the surface perpendicular to the intersection of its plane with the surface.

It should be clearly understood that the total force is equal to the area multiplied by the force at the centre of area.

Centre of stress

This is the point at which the stress in a beam may be considered to act.

$$f = \frac{Md}{I} = \frac{M}{Z}$$

$$= \frac{Md}{Ak^2} = \frac{M}{A^1k^2/\bar{x}}.$$

As the datum is taken through the centre of area, both portions of the 1st derived area are equal.

$$Z = A^1\left[\left(\frac{k_1}{\bar{x}}\right)^2 + \left(\frac{k_2}{\bar{x}}\right)^2\right]$$

$$Z = A^1\delta$$

or

$$Z = (d_1A_1{}^{11} + d_2A_2{}^{11})$$

where

A^1 = area of *either* portion

δ = distance apart of centres

EXAMPLE. (Fig. 3, Beam section).

$$\delta_1 = 8.93 \times \frac{7.61}{9.92} = 6.85 \text{ in.}$$

$$\delta_2 = 7.57 \times \frac{7.13}{9.92} = 5.44 \text{ in.}$$

$$\delta = 6.85 + 5.45 = \underline{12.3} \text{ in.}$$

$$Z = 9.92 \times 12.3 = \underline{122.02} \text{ in.}^3$$

Lateral position

To determine the lateral position of a centre of pressure, a floating centre must be used as origin for the derived area. This is taken on the bisector of each horizontal ordinate where it intersects the waterline. The centre of pressure is at the centre of area of this derived area.

Centre of volume of revolution

It is useful to note that the centre of volume of revolution is on the axis of revolution at the foot of the perpendicular from the centre of pressure and therefore easily deduced.

The units shown above are typical of load cells used for weight measurement and are described in the text.

What is a load cell—how does it work?

In certain types of measurement they offer some special advantages

Electric-type load cells, properly used with electronic instruments, are finding many important new applications for weight measurement. They offer special advantages for measurements involving such difficult factors as:

(1) impact and vibration
(2) adverse ambient conditions
(3) high speed measurements
(4) awkward mechanical structures
(5) portable equipment

Frequently, combinations of these factors in a given installation make weight measurement with load cells spectacularly successful.

In addition to the special advantages, load cell systems have several inherent features. They can easily provide a remote indication or continuous recording of weight, with the addition of automatic control (if desired).

Further, systems can be set to indicate a differential weight above or below any given value as, for example, 100 lb over a base load of 10,000 lb.

Sensitivity and accuracy are characteristics that vary with the specific load cell system. The potentials of the method are, however, dramatically indicated by the case of a 500-lb range cell, capable of detecting 1-oz washers, a sensitivity greater than 1 in 300,000.

This article reviews the basic characteristics of load cell measurement and gives examples of typical industrial applications. These examples will help users visualize other possible applications or means of improving present measurements.

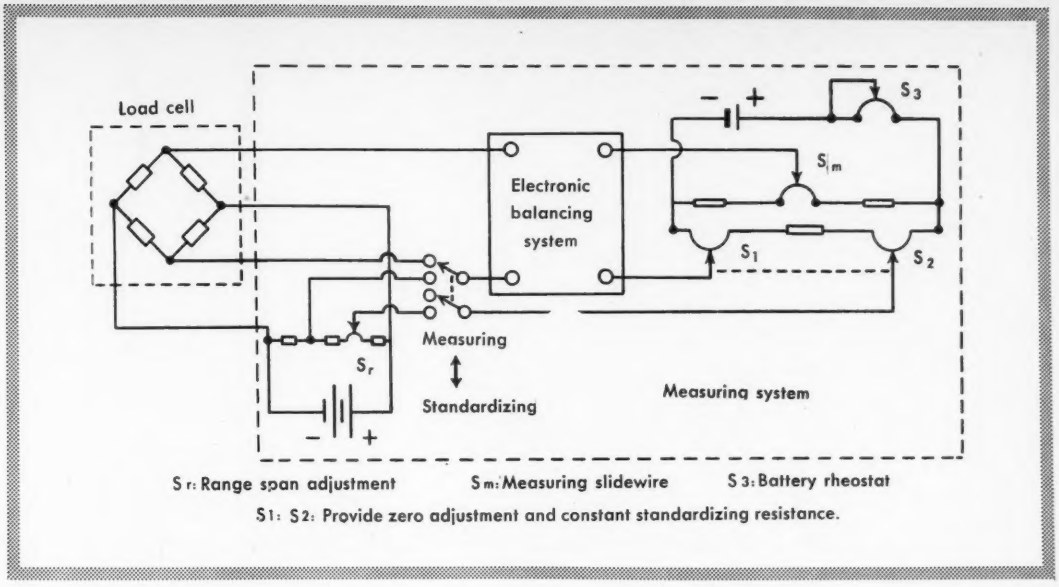
LEEDS & NORTHRUP CO.

The load cell may be defined as a weight-measuring unit, with an output signal capable of transmission to a remote point. In its most commonly used form, the cell employs an electric signal which a suitable instrument translates into an indication or continuous record.

Load cells have one basic characteristic that must be clearly understood: their output signal depends on the elastic properties of a structural element which supports the weight being measured. This relation has been refined, compensated and improved by a number of ingenious methods. However, measurement of weight by a load cell is fundamentally a deflection measurement.

The deflection factor is important for, in order to realize the maximum advantages of load cell measurement, some problems require that the gross load be supported by the cell or a group of cells, whilst others may dictate that only a fraction of the load be applied to the cell. Hence load cells must be used with various mechanical devices to balance tare load, provide overload protection, improve accuracy and otherwise insure dependable performance. The application engineer must thoroughly understand that the device is equivalent to a calibrated spring, or a "fish scale," rugged and refined as it may be.

The load cell operates on the principle that the resistance of a wire increases as the wire is stretched under load. Thus, by a suitable arrangement of wires in a unit subjected to load, the weight can be related to this resistance change. The resistances are arranged in a bridge network, so that the output voltage signal is proportional only to the resistance change produced by the load. Temperature and other effects on the



resistance values are cancelled. The output voltage is then measured on a precision potentiometer-type instrument. A typical circuit diagram is shown.

With a basic understanding of load cell principles, consider now the special advantages offered by load cells in solving difficult weight-measuring problems.

Vibration and impact. The compactness and rigid construction of the cell allow tight coupling between the load and the foundation structure. Under vibration therefore, the force applied to the load cell varies, but no relative motion between the parts occurs and damage to bearing points is thus eliminated. The signal generated by the cell follows the vibrating load, but simple electrical filters suppress this without difficulty. Weighing hoppers on lorry cars (and metering bins with vibrator-type discharge feeders) are examples of problems that have been successfully solved.

Impact loading is a somewhat more difficult problem for, as noted previously, load cells depend on the elastic properties of some structural element. If the elastic limit is exceeded by an overload (accidental or otherwise) an irreversible zero-shift results. Oddly, this same elastic deflection is the basis of one of the simplest methods for the protection of load cells. In several rocket test stands, a rigid overload stop bears the load after the cell has been strained to its rated capacity.

Usually, for industrial service, the precise positioning required by such a stop is impracticable. For such problems, the total deflection of the system may be increased by inserting a softer spring element between the load and the load cell, and an overload stop spaced at a more convenient distance.

Adverse ambient conditions. The measurement of weight where corrosive materials and water are present (as in chemical and water treatment plants) presents a difficult problem, to which there is no perfect answer. The simpler the structure, however, the easier it is to protect and maintain the equipment. The load cell thus comes into its own, because a tank or platform (resting on 3 or 4 rigid, sealed units) offers just about the ultimate in simplicity.

The weighing units of such a system may be given a coat of corrosion-resistant paint for additional protection, without impairing the accuracy of measurement. In some installations, the cells are regularly hosed down with water to avoid the accumulation of corrosive material or to maintain sanitary conditions.

Load cells are quite satisfactory where fine abrasive dust is present. Sand particles in foundries and fly-ash near large coal-fired boilers take a severe toll on any moving system. Several successful applications of load cells have been made in dusty areas like foundries.

High-speed measurement. Higher and higher speed of measurement is a fundamental need in our advancing technology and in the rapid extension of automation. Load cells have helped to lessen the speed limits in the measurement of weight. The reason may again be traced to the fact that load cells function by virtue of an elastic deflection. In most units, the total motion is small.

In a typical Baldwin-Lima-Hamilton SR4 type cell, for example, the deflection at full capacity is approximately 0.005 or 0.006 in. Inherently, such a device has a high natural frequency; that is, it is capable of following (accurately) very rapid changes in applied force. Some of the most spectacular applications of load cells are in testing rocket engines, jet-aircraft supersonic wind-tunnel models and the like.

Successful industrial weighing applications of load cells by Streeter-Amet, IBM and others include problems of motor truck logging on turnpikes, railroad switch yard weighing and so forth. In several industrial problems involving repetitive operations on product weight (on which Leeds & Northrup have worked) the high speed of response possible with load cells was an important factor in achieving a satisfactory solution. In industrial laboratories (such as a helicopter-rotor test stand) load cells and load cell instrumentation played a vital role in accurate measurement.

Awkward structures. Properly supporting certain types of structure and at the same time realizing a useful weight measurement, is an awkward problem that has considerably promoted the use of load cells. A dramatic example is the railroad track scale installed several years ago by Baldwin-Lima-Hamilton and since re-

Continued on page 69

Missiles, computers, servomechanisms and other devices that need to keep their power transmissions small can use these couplings

Miniature couplings have been developed by The Thomas Flexible Coupling Company for use on servomechanisms, computers, missiles and other devices requiring small-size components for power transmission. They are non-magnetic and light-weight, with low elastic yield under torque and are smaller than a car ignition key in length and a half-dollar in diameter.

They are made entirely of non-ferrous material such as anodized aluminum alloy, beryllium copper and brass except for the stainless steel set-screws. Couplings of materials other than these can be furnished for special applications, however. Special steels may be specified for high-strength applications where magnetic effects are of no concern, or a wide variety of non-ferrous materials may be used to permit operation in corrosive atmospheres, under high temperatures or where the insulating properties of the coupling materials are an important factor.

The couplings are available in many different sizes and types, which can be individualized to meet particular requirements. Bores and hubs can be engineered for coupling non-standard shafts or for couplings to flanges of special design.

If properly installed and operated within rated conditions, these miniature couplings will last a life-time. They require neither lubrication nor maintenance, since there are no wearing parts. Designed for speeds up to 50,000 rpm they hold synchronism, relieve bearing loads, give reliability of compliance and compensate for parallel and angular misalignment.

Details of three styles of coupling are shown on the right.

Floating shaft coupling

To meet the requirements for small, high and low speed couplings a floating shaft (Type 50 CE) coupling in miniature sizes has just been introduced.

The floating shaft is held concentric by flexible disc rings at both ends. The extended distance between the disc rings permits more misalignment capacity than when the disc rings are close together. Shafts may be either solid or tubular.

This type of coupling can be used with semi-floating type couplings to make long power transmission shafts with a minimum of bearings. The elimination of as many bearings as possible makes for better power transmission and fewer likely sources of trouble.

It also provides a method of clearing obstructions when two drives are close together; one can be coupled with the standard length coupling and the other with a floating shaft coupling which will stagger the driving units and save space.

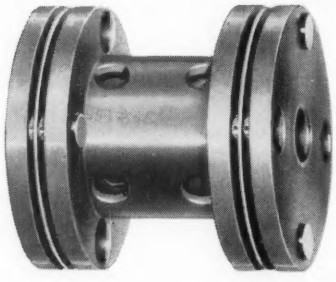
Semi-floating type.

The semi-floating shaft would be the same as the above but with a single-flexing coupling on one end only; the other end is supported by an outboard bearing.

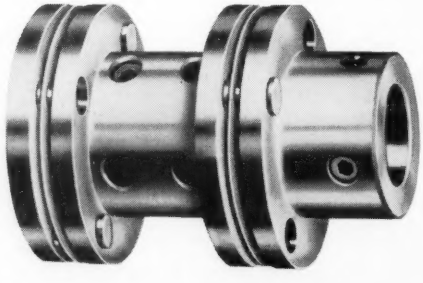
The semi-floating shaft type of flexible coupling fulfills a very definite need by reducing the bending moment caused by misalignment in spans of three or more bearings and doing it without introducing any adverse features. In fact, it does away with the parallel misalignment so difficult to take care of. It operates as a rotary hinge.

The principle of the Thomas flexible coupling is such that it drives like a solid coupling but has flexibility to take care of misalignment and end float. It is claimed to be the only flexible coupling that will support weight while transmitting torque and at the same time provide flexibility without pilot bearings. ★

Style CC



Style CA



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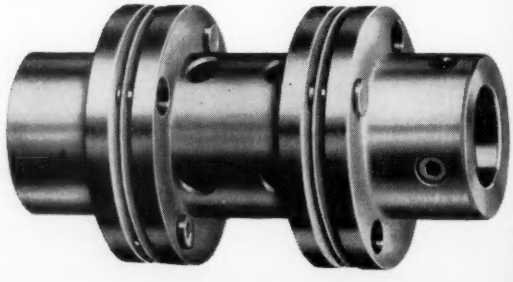
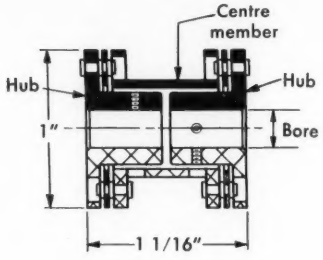
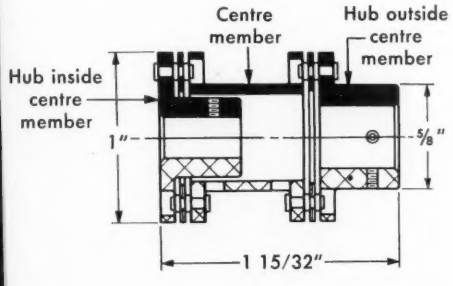


Pint-sized couplings scrimp on space



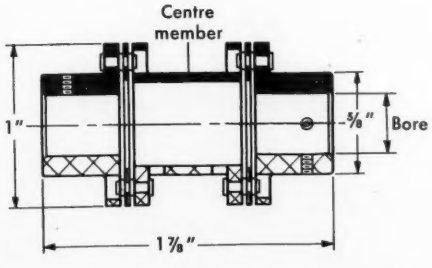
In this design, both hubs are inside the centre member.

Style	Standard Bore Sizes (in.)	Torque Capacity (in.lb.)	Weight (oz.)
25 CC	⅛ to ¼	3.1	0.67
37 CC	⅛ to ⅜	15	1.9[B]
60 CC	3/16 to ½	60	3.89



In this design, one hub is arranged inside and the other outside the centre number.

Style	Standard Bore Sizes (in.)	Torque Capacity (in.lb.)	Weight (oz.)
25 CA	Hub inside centre No. ⅛ to ¼ Hub outside centre No. ⅛ to ⅜	3.1	0.74
37 CA	⅛ to ⅜ ⅛ to ½	15	2.02
50 CA	3/16 to ½ 3/16 to ⅝	60	4.02



In this design, both hubs are arranged outside the centre member.

Style	Standard Bore Sizes (in.)	Torque Capacity (in.lb.)	Weight (oz.)
25 CB	⅛ to ⅜	3.1	0.81
37 CB	⅛ to ½	15	2.11
50 CB	3/16 to ⅝	60	4.15

And where did the Canadians get to?

A brief report on the third Design Engineering Show and Conference

John W. Dennis ASSISTANT EDITOR

Showmanship

Chicago 5.30 p.m.—April 14. The last of the footweary are now leaving the giant International Amphitheatre in the heart of Chicago's stockyard district.

Over 6,500 of them have come to try, learn and look at more than 400 booths on the first day of this, the third Design Engineering Show. Already America's third largest annual industrial exposition and conference, reasons for such success are easy to find. In a compact 125,000 sq. ft. rectangle of exhibit space a visitor can see, in a half day session of hard walking, all the latest and best currently offered, by companies great and small, in materials, methods components and finishes.

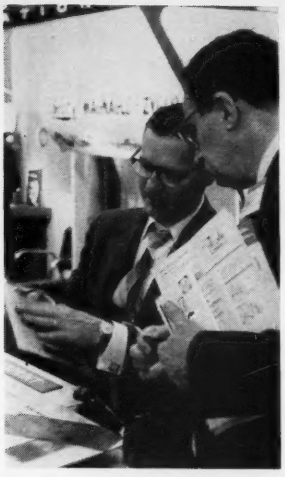
Showmanship and straight talk are both making a pitch—each has been effective in packing the curious into the booths.

Although final attendance figures won't be ready for several days, it seems certain that the final tally for the Canadian contingent will be small. More's the pity, for there probably isn't a show anywhere, regardless of size or location, that is so much of an **idea** show.

A fast check just made around the booths on the display floor has failed to turn up a single all-Canadian company with the courage to match their products and ideas against these from the U. S. Many of the booth signs, however, are equally familiar north and south of the border.

The current recession, described in terms ranging from "marking time" to "a slump" may take the blame

To look . . .



to touch . . .

to learn . . .

. . . and to try

for making Canadians conspicuously absent. Exhibitors, however, are aggressively (if not completely convincingly) optimistic. Witness one booth where the attendants are passing out cards cut to fit the breast pocket. The protruding legend reads: "Business is good. We think it's about time everybody quit griping and went to work."

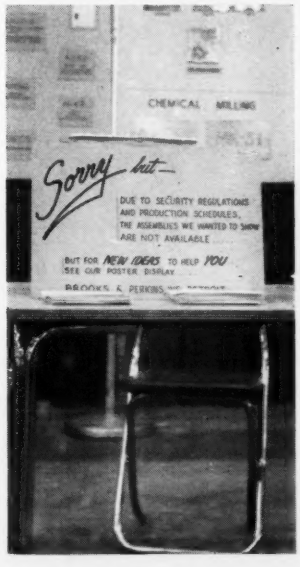
Most of the visitors crowding the exhibition hall have come to learn by looking rather than by listening. Nevertheless, there's a 4-day conference of talks and panels during the mornings of the show.

A very special mention, for an idea that every such show should adopt, must go to the Enquiry Time Saver. At most such exhibitions the intrigued booth-shopper spends excessive time writing his name, occupation and address on cards to ensure getting literature from the manufacturer whose display made him pause.

The Chicago show has the problem neatly licked. Each visitor can get a metal plate with the necessary details embossed on it. Every exhibitor has a device which will take an imprint of the plate in less time than it takes to read this sentence. The service is free and foolproof.

Design Engineering will have more to say on this show later. Our deadline prohibits anything more than this brief report. Summary: A good show and a big one. Plenty for everyone to see. You should have been there.

nothing to show



BUSHING TYPE	MATERIAL	RELATIVE COST INDEX
Federal HF-2	sintered bronze on SAE 1010 steel	1.22
HF-3	sintered bronze on SAE 1010 steel	1.20
HF-16	sintered bronze on SAE 1010 steel	1.29
RS-21	solid wrought bronze	2.29
B-100	tin babbitt on SAE 1010 steel	1.60
L-200	lead babbitt on SAE 1010 steel	1.00
L-300	lead babbitt on SAE 1010 steel	1.09
A-200	aluminum on SAE 1010 steel	1.40

The facts you should know on bushings

Grooves: In many bushing applications it is necessary to have grooves to improve the lubrication of the bushing. The most economical method of forming these grooves is by stamping or coining them in the flat banks prior to the forming of the full round bushing. Grooving patterns vary and are limitless but Fig. 1 shows some of the more popular varieties in use.

The controlling factors in groove design are: press capacity; groove width and depth; and the characteristics of the bushing material. The groove cross-sections shown in Fig. 4 are typical of those that are readily formed. Grooved cross-sections of greater width or depth would necessitate machining of the grooves. Whenever possible, of course, machined grooves should be avoided because of the high cost of this operation.

Oil holes: For maximum economy, oil and grease holes are stamped in the flat bushing blank. As the bushings are formed, these holes become slightly narrowed perpendicular to the bushing axis. This should be taken into consideration when establishing the hole size and its location in the bushing. Special applications may require odd-shaped lubricant holes and there is no limit to the variations of these cut-outs, provided they can be inserted in the flat bank with a die set. Fig. 2 shows some of the cut-outs that have been volume-produced.

This article on formed bushings has been prepared from information supplied by Federal-Mogul-Bower Bearings, Inc. The materials, standard sizes and grooving patterns described will satisfy practically all conventional applications of formed bushings.

A relative cost index is quoted in the table of types.

Seams: For maximum economy, most strip bushings are produced with **straight seams.** In the free state, these seams may have a gap opening of 1/64 to 1/16 in., depending on the bushing material and its hardness. These open seams may cause jamming or fouling of automatic assembly equipment, in which case **lock seams** can be employed at a slight additional cost (Fig. 3).

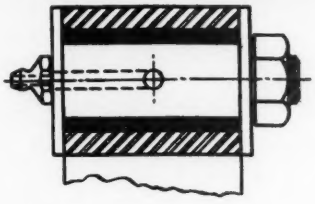
Single, double or triple locks may be used, depending on the ratio of length: diameter of the bushing. The number and shape of the locks should be left to the discretion of the bushing manufacturer. All precision type bushings are manufactured with lock seams.

Chamfering: Formed strip bushings may be obtained with two types of end chamfer on the OD and ID as shown in Fig. 6. The scored chamfer is the more economical, for it can be formed while still in the flat blank. If a chamfer of greater accuracy is required to assist in intricate assembly operations, machining of the chamfer is necessary.

Ball indentations: Ball indentations (Fig. 5) on the surface of the bushing provide small reservoirs that retain the lubricant and are very helpful in grease-lubricated applications, for they ensure good lubrication during initial starting. The indentations may be used with any groove cross-section or pattern. Babbitt-lined bushings cannot, however, be ball indented.

Ball indentations serve well as anchor pockets when used on the OD of bushings that are to be die-cast into housings [Fig. 5(c)]. **Continued on page 57**

Spring Eye Bushing



Slight oscillation: grease lubricated. Loading is 5,000 psi with high shock.

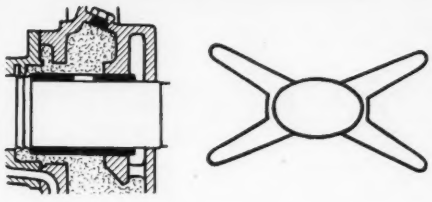
Bushing:

Straight seam (Type A, Fig. 4).
Material: HF-2 or HF-3 (see Table), sintered bronze on SAE 1010 steel. Wall thickness range 0.094 to 0.187 in. nominal, after finishing in place. Lining thickness: 0.020 to 0.035 in. after finishing in place.
Finish at assembly by reaming or boring.

Shackle pin:

Size range 0.5 to 1.75 in.
Finish 20 micro-in. RMS
Hardness R_c 60
Average life 15,000 miles

Electric Motor Bushing



Rotary motion: oil-lubricated waste pack or wick. Lubricating oil temperature is 125F. Grooves are of type shown. Loading 100 psi.

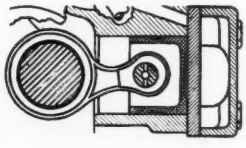
Bushing:

Straight seam, RS-21 (solid wrought bronze) or B-100 (tin babbitt on SAE 1010).
Wall thickness range: 0.031 to 0.062 in. nominal after finishing in place.
Lining thickness: 0.010 to 0.015 in. after finishing in place.
Finish at assembly by boring or reaming.

Shaft:

Speed: 3600 rpm
Size range: 0.375 to 1.0 in.
Finish: 16 micro-in, RMS
Hardness: R_b 75
Average life: 25,000 hr.

Refrigerator Compressor Bushing



Rotary motion: pressure or splash oiling: loading 1,500 psi. Lube oil temperature is 210 F.

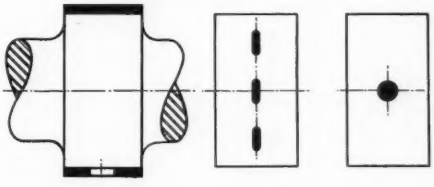
Bushing:

Material: B-100 (tin babbitt on SAE 1010) or HF-16 (sintered bronze on SAE 1010). Wall thickness range: 0.062 to 0.093 in. nominal after finishing in place. Also available as full precision type requiring no finish after assembly.
Lining thickness: 0.005 to 0.010 in. after finishing in place.

Shaft:

Speed: 1,740 to 2,340 rpm
Size range: 0.75 to 3.0 in.
Finish: 8 to 20 micro-in., RMS
Hardness: Cast—R_c 20 to 30: forged—R_c 55
Average life: 20,000 hr.

Camshaft Bushing



Rotary motion: loading 350 psi: pressure oiling: oil temperature 275 F.

Bushing:

Material: L-200 (lead babitt on SAE 1010) Wall thickness range: 0.062 to 0.093 in. nominal after finishing in place. Also available as full precision type requiring no finish after assembly.
Lining thickness: 0.005 to 0.015 in. after finishing in place.
Finish at assembly by reaming or boring. Full precision type does not need final finishing.

Shaft:

Speed: 2,500 rpm max.
Size range: 1.0 to 3.0 in.
Finish: 16 micro-in., RMS
Hardness: R_c 20 to 30
Average life: 5,000 hr or 150,000 miles

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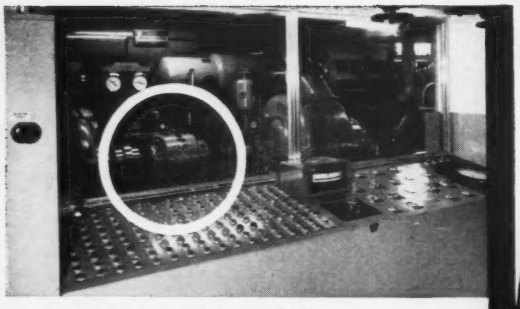
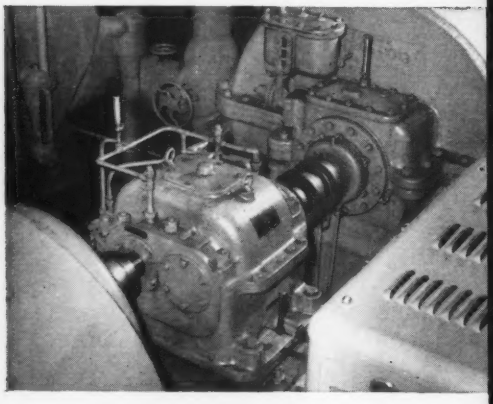


AT WORK IN TORONTO in the Canada Permanent Trust Building.



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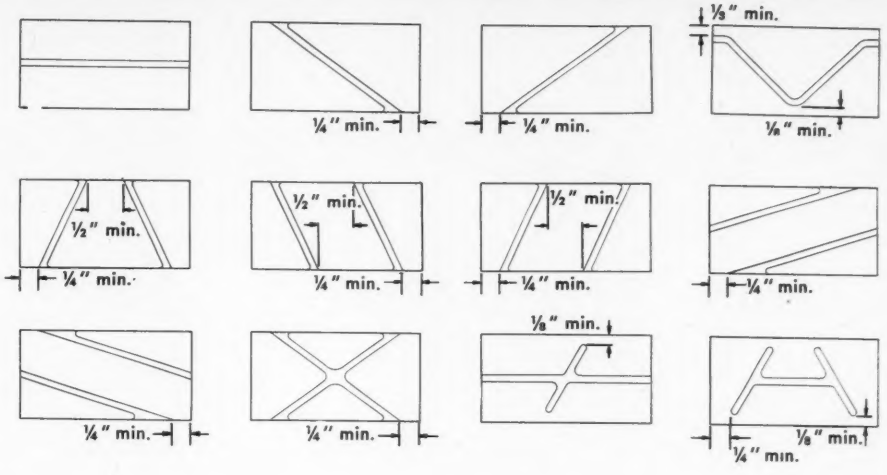
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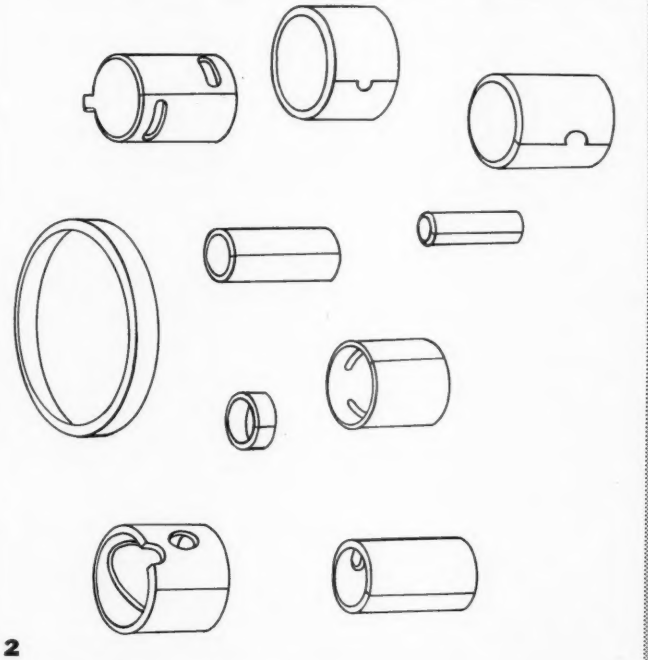
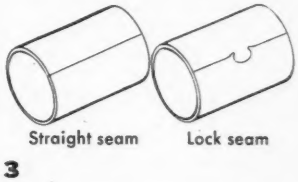
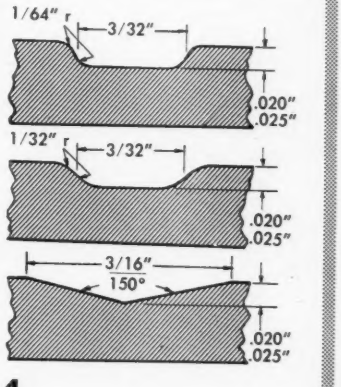
1



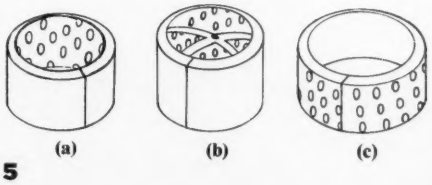
2


Straight seam
Lock seam

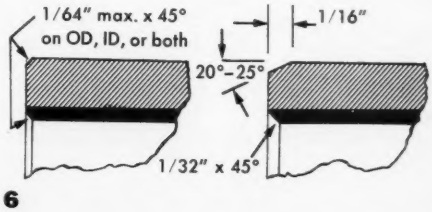
3


1/64" r
3/32"
.020"
.025"
1/32" r
3/32"
.020"
.025"
3/16"
150°
.020"
.025"

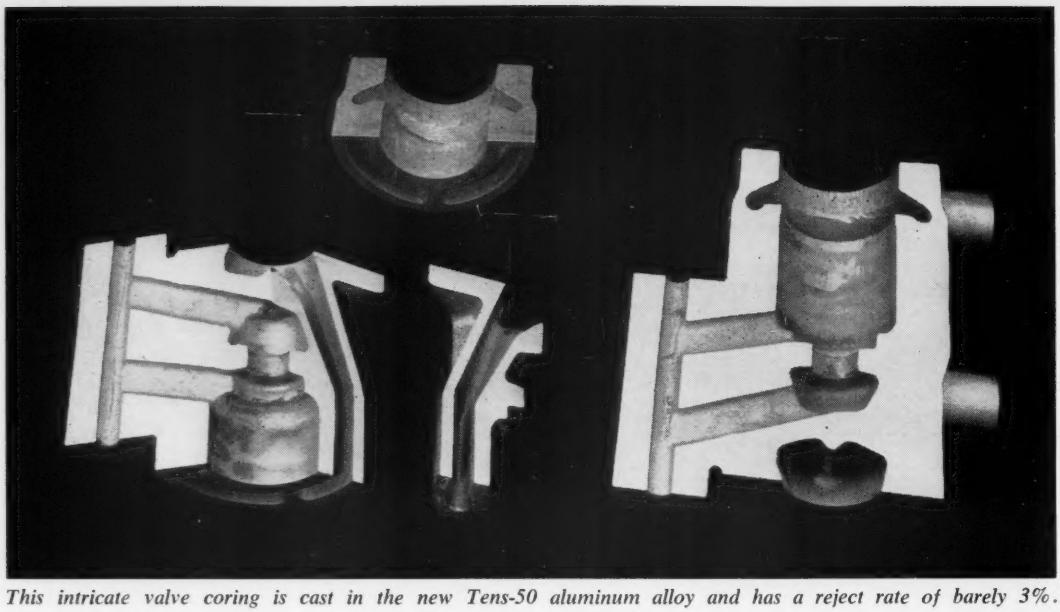
4


(a)
(b)
(c)

5


1/64" max. x 45°
on OD, ID, or both
1/16"
20°–25°
1/32" x 45°

6



This intricate valve coring is cast in the new Tens-50 aluminum alloy and has a reject rate of barely 3%.

Light alloys for casting tricky shapes

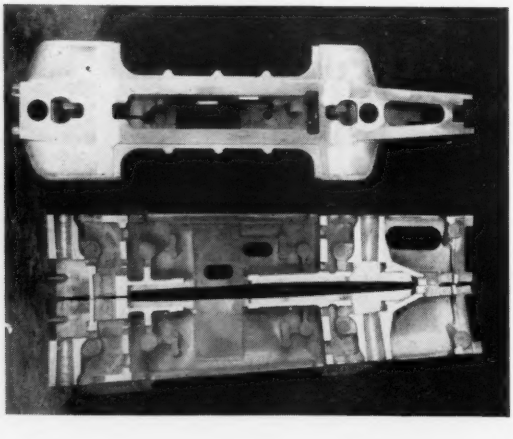
Design engineers can now use castings of a new aluminum alloy. Trade-named Tens-50, the alloy represents a new approach to alloying for high strength casting from the conventional "purity" methods. Beryllium and sodium are used to neutralize the embrittling effect of iron and silicon. Thus, consistent results under average foundry conditions can be expected. The new alloy gives a 25 to 40% weight saving.

Mechanical properties are given in Table 1, comparative strength figures in Table 2 and physical properties in Table 3. These mechanical properties are the average for sections varying in thickness from ⅛ to ¾ in.

Since it is an exceptionally free-flowing alloy, Tens-50 can be cast in complicated shapes with minimum rejection rates by sand or permanent mold methods.

In one sand casting, for instance, a valve (subjected to 1,100 psi burst pressure) consisted of a thinwall inner compartment supported by integral studs to an outer shell, with three corings for drain purposes. In the 356 alloy, the reject rate ran over 36%. In Tens-50, the reject rate ran a bare 3%.

This pylon mold used 7 metal cores and 6 sand cores.



In one permanent mold, a valve (subjected to 7,500 psi burst pressure) failed to test beyond 5,600 psi in the 356 alloy. Tens-50 alloy, poured in the same mold, tested to 10,000 psi without failure.

Whilst the modifying additives in the alloy were added primarily to enable the average foundry to produce castings with a consistently higher strength at room temperature, advantages are also observed at elevated temperatures. At 400 F, the ½ hour curve forTens-50-T6 sand casting reveals an expected ultimate tensile strength of 30,000 psi compared to the 23,000 psi that the 356-T6 alloy may be expected to retain. The yield tensile strengths are 25,000 psi and 19,000 psi respectively. Tens-50-T6 alloy, when exposed to 400 F for 10 hr, may be expected to retain the following percentage of room temperature characteristics:

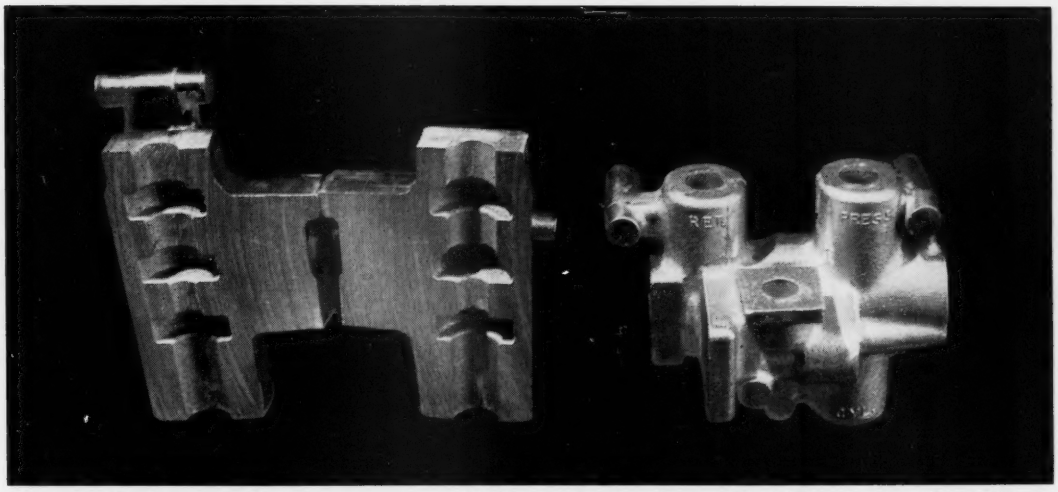
Sand casting:	
Ultimate tensile strength	62%
Yield tensile strength	72%
Permanent mold:	
Ultimate tensile strength	72%
Yield tensile strength	72%

The alloy exhibits no corrosion when chrome-acid-anodized and flash-hard-anodized specimens (machined or un-machined) are subjected to a standard 90% hydrogen peroxide compatibility test.

Fatigue tests indicate that the Tens-50-T6 alloy's fatigue properties are superior to those of the 356 alloy, but not as great as is the increase in static properties. ★

Table 1. Mechanical Properties of Tens-50-T6

	Sand castings		Permanent mold castings	
	Typical	Suggested design minimum	Typical	Suggested design minimum
Ultimate tensile strength psi	46,000	42,000	50,000	45,000
Tensile yield strength (0.2% offset) psi	36,000	32,000	44,000	38,000
Compressive yield strength (0.2% offset) psi	36,000	32,000	41,000	38,000
Ultimate shear strength psi	41,000	35,000	44,000	38,000
Ultimate bearing strength (e/D = 2.0) psi	98,000	88,000	103,000	94,000
Bearing yield strength (e/D = 2.0) psi	62,000	56,000	73,000	67,000
Elongation % on 2 in.	5	3	6	3



Valve specifications needed a burst pressure of 7,500 psi Regular alloys took 5,600 psi., Tens-50 10,000 psi.

Table 2. Design Minimums For Tens-50

Method	Alloy	Tensile Strength (psi)	Yield (psi)	Elongation (%)
Forging:	2014-T6	65,000	55,000	10
	6061-T6	38,000	35,000	10
Permanent mold:				
	Tens-50-T-6	45,000	38,000	3
	356-T6	33,000	22,000	3
Sand casting:	Tens-50-T-6	42,000	32,000	3
	356-T6	30,000	20,000	3

Table 3. Physical Properties of Tens-50-T6

Density (lb per cu in.)	0.960
Coefficient of thermal expansion (in./in. per deg F)	
68-212 F	11.9×10^{-6}
68-392 F	12.7×10^{-6}
68-572 F	13.0×10^{-6}
Electrical conductivity (% of int. annealed copper std.)	39
Thermal conductivity (at 25 C, CGS units)	0.36
Specific heat (Cal per gm at 212 F)	0.23

Ideas round-up

Stainless steel: the problems in casting it

The minimum thickness of a section can be determined from strength and rigidity calculations which may show that certain sections can be very thin. In practice, however, the minimum thickness of any section is limited by the castability of the metal; that is, the fluidity of the molten metal as it runs through the mold. Further, this minimum section thickness depends on the distance the metal must run from the gate that delivers it.

For stainless steel, the minimum section thickness is arbitrarily set at ¼ in. when the longest dimension of the cast part is less than 12 in. In practice, thinner sections can be run when they are located close to the gate, but this value must be used by the design engineer since he does not know where the foundryman will locate the gate.

The curve should be used to determine the minimum section thickness when the longest dimension of the cast part exceeds 12 in. This curve represents standard design conditions, wherein the molten stainless metal enters one position in the mold and must run the length shown. It should be noted that foundrymen have developed special techniques for running thinner sections extending over the entire length of the graph. The application of these techniques, however, adds extra cost to the production of the cast part. (From information supplied by Alloy Steel Casting Co.) (201)

Color-coding: for punched laminated plastic panels

An inexpensive method of color-coding punched laminated-plastic panels (in virtually any number of colors and on any size panel) has been developed by the Taylor Fibre Co.

First applied to coding terminal plates for fractional hp motors (where the color relates each wire to its proper contact) the new method is expected to have almost unlimited possibilities for similar applications in the electrical and electronics fields.

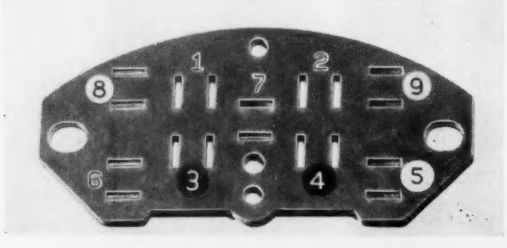
The coding can be printed on any type of laminate for such applications as: connector plates, motor and generator terminal panels and printed circuit terminal strips.

The coding is accomplished through the use of a special, automatic printing system (developed by Taylor Fibre) which prints all panel coding in a single operation after the panel is punched.

Color-coding provides a positive identification of contacts or terminals to speed assembly and reduce the chance of incorrect internal wiring and external hook-up. Coding which provides for fast terminal identification facilitates routine maintenance, reduces machine downtime and assures correct connections when a machine must be replaced.

An additional benefit for motor manufacturers is the saving resulting from the purchase of large quantities of a standard punched panel for all motors, instead of small quantities of different panels for each type.

One standard terminal panel can be ordered and color-coded inexpensively in as many ways as necessary to differentiate the panels for each variation in type or rating in the motor line. (202)



(Continued on page 62)

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Memory meter: retains a reading indefinitely

A "memory meter" that retains indefinitely a reading taken at any desired instant has been developed by Assembly Products, Inc.

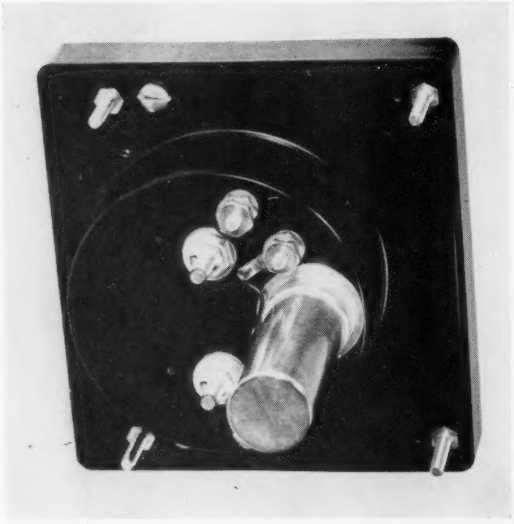
Believed to be the first of its kind, the device is a simple, reliable means of achieving results that have hitherto required fairly complicated electronic equipment.

The memory meter is especially suitable for applications where readings at a given time must be known but cannot be noted immediately. Such situations include remotely-located meters (or batteries of meters) with a number of different but related readings. Readings may be taken at any point on the meter scale and not necessarily at the maximum reached by the signal.

The new unit is essentially a sensitive panel meter with a rear-mounted solenoid that is normally energized so that its plunger is retracted. When a reading is desired, the solenoid is de-energized. Its nylon-headed plunger pushes against the back of the face plate, which is normally held away from the pointer by two small springs at its base. The pointer is held fast at the reading instant between the face plate and a clamper plate, mounted over the top arc of the face plate.

If desired, operation of the solenoid can be reversed so that the coil is normally de-energized. The solenoid must then be energized to permit free movement of the pointer.

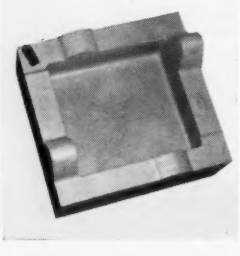
The memory meter is available in almost any sensitivity range, from a few microamps (or millivolts) to 50 amps (or 500 volts), either dc or ac. It is built on a 4½ in. rectangular plastic case, which looks like a conventional API panel meter from the front. In present models, the solenoid coil operates on 100 volts dc and about 30 milliamps but smaller dc solenoids may be used. An external rectifier may be used with the solenoid, if ac current is used. (203)

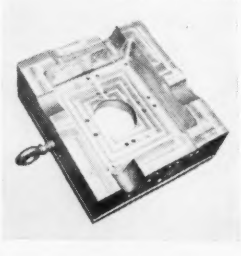


Cast-to-shape retainer: $1,200 saved

Over $1,200 was saved when a large die casting firm used a cast-to-shape retainer in place of a forged die block to hold automobile horn dies. The forging and casting division of Allegheny Ludlum Steel Corporation supplied the steel (designated FC CMS) to the Congress die casting division of Tann Corporation, Detroit. FC CMS is an oil or air-hardening steel most commonly provided in cast-to-shape form.

The economical cast-to-shape retainer weighed 600 lb less than the forged die block it replaced. If a forged block (normally supplied hardened and ground) had been used to hold automobile horn dies, a 1,250 lb block would have been specified.



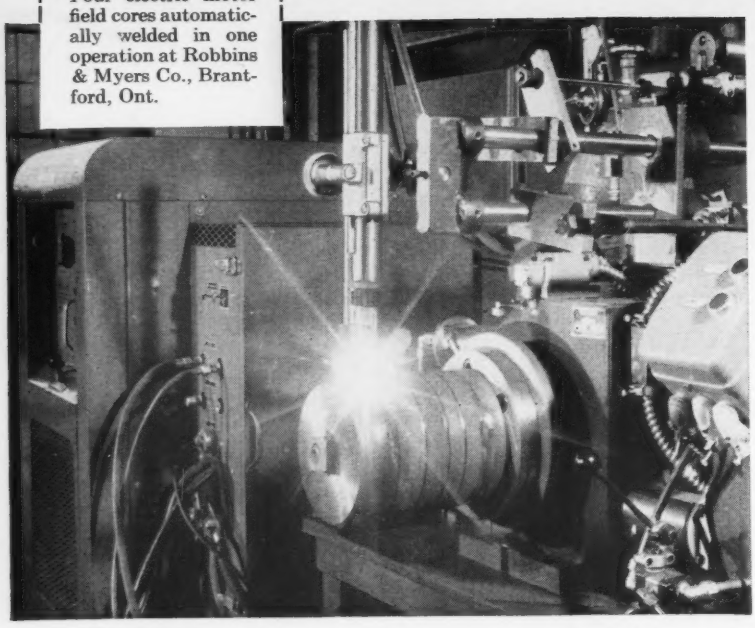


A casting like that used by Congress has only ¼ to ⅜ in. of machine stock on all surfaces, requiring one roughing and one finishing operation.

FC CMS was hardened and drawn to a hardness of 262 brinell for the automobile horn die retainer. The steel hardens accurately, and gives superior performance in forming dies in the cast-to-shape form, where extraordinary toughness is required. Despite its toughness and hardness, the metal is still machinable. No additional heat treatment is needed after machining.

The CMS material is normally supplied pre-hardened 241/269 brinell or 255/277 brinell. The hardness depends on the customer preference, the amount of machining to be done and the thickness of the section.

Aluminum and zinc die casting manufacturers who use dies weighing over 400 or 500 lb will find cast-to-shape die retainers excellent substitutes for the costly forged die blocks. Operations where there are radical changes in the parting line lend themselves to the use of cast-to-shape retainers. (204)



Four electric motor field cores automatically welded in one operation at Robbins & Myers Co., Brantford, Ont.

Automatic ARGOWELDING doubles production rate

FIVE YEARS AGO, Robbins & Myers Co. of Canada Limited, a leading electric motor manufacturer, recognized the many production advantages of automatic Argowelding. The first automatic Argowelding machine proved so efficient in raising quality and increasing production that a new unit has been installed for high-speed assembly of electric motor field cores. These cores, a series of thin steel laminations tightly packed together, are welded automatically, four at a time.

Argowelding equipment is completely automated. When the control button is pushed, the Argoweld torch with its argon-shielded arc moves across the laminations at a pre-set uniform speed, fusing the edges together. No filler metal is used. On reaching the opposite side, the arc is broken, the fixture indexes the arc assembly, the arc is struck again with the torch travelling in the opposite direction, and so on.

Robbins & Myers report that assembly is done more efficiently, in half the time previously required, and production has been doubled.

For complete information on automatic Argowelding, or any gas or arc welding process, equipment or supplies, contact your nearest L.A. Branch or authorized dealer.

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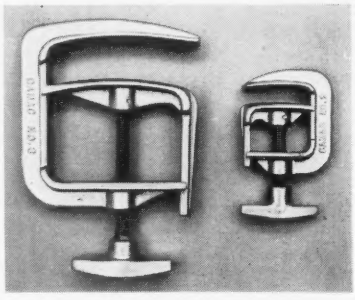
Hose valves

Camac hose valves will effectively regulate or shut off flow through hose and are available in two sizes. Size No. 2 is made for hose from ½ in. to 1 in. ID and size No. 3 for hose from 1 in. to 2½ in. ID.



The valves are made of rustproof aluminum with a bronze threaded stem. Light aluminum construction provides a minimum weight drag to hang on hose. They can be slipped on any hose run without disconnecting the hose, and are satisfactory to pressure of 100 psi. (205)

Glass-epoxy laminate

A new glass-epoxy plastic laminate has been developed by **Taylor Fibre Co.** especially for use in making copper-clad laminates for printed circuits.

The glass base epoxy resin laminate is furnished either plain or with copper cladding on one or both sides. The copper-clad grade can be supplied with the copper bonded to the base laminate with or without adhesive.

The copper-clad materials are readily flushed; that is, after the panel is etched the resulting circuit or copper design is easily pressed down to make it flush with the base laminate. Sheets up to ⅛ in. thick (whether plain or copper-clad) can be punched. The material is easily machined. (206)

Rotary solenoid

A complete data sheet covering the specifications and operating data of a new type of rotary solenoid is being offered by **Leetronics Inc.**

These solenoids (called Motoroids) feature a new concept in design that provides true rotary motion without linkages. In addition, both angle of rotation and torque curves are easily adjusted and changed. (207)

(Continued on page 70)

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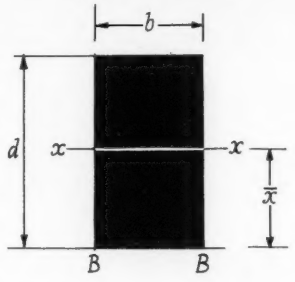
Section properties

RECTANGLE



Area $A = bd$

Position of neutral axis xx

$$\bar{x} = d/2$$

Moment of inertia

$$I_{xx} = \frac{bd^3}{12}$$

$$I_{BB} = \frac{bd^3}{3}$$

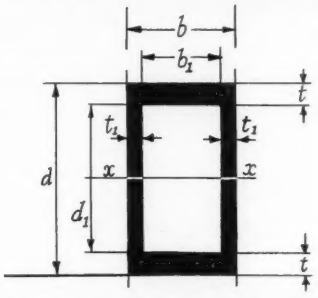
Section modulus

$$Z_{xx} = \frac{bd^2}{6}$$

Radius of gyration

$$\rho_{xx} = \sqrt{\frac{I}{A}} = \frac{d}{\sqrt{12}} = 0.289d$$

HOLLOW RECTANGLE



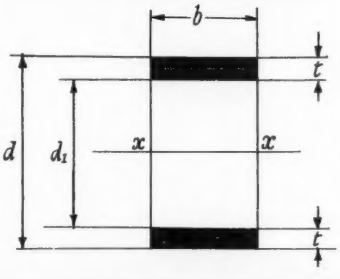
$$A = bd - b_1d_1$$

$$I_{xx} = \frac{1}{12}(bd^3 - b_1d_1^3)$$

$$Z_{xx} = \frac{1}{6d}(bd^3 - b_1d_1^3)$$

$$\rho_{xx} = \sqrt{\frac{I_{xx}}{A}}$$

RECTANGULAR SLEEVE



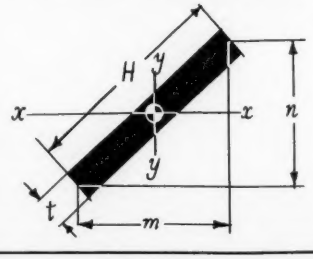
$$A = b(d - d_1)$$

$$I_{xx} = \frac{b}{12}(d^3 - d_1^3)$$

$$Z_{xx} = \frac{b}{6d}(d^3 - d_1^3)$$

$$\rho_{xx} = \sqrt{\frac{I_{xx}}{A}}$$

INCLINED RECTANGLE



$$A = Ht$$

$$I_{xx} = \frac{A}{12}\left[n^2 + \left(\frac{tm}{H}\right)^2\right]$$

$$= \frac{An^2}{12} \text{ when } t/H \text{ is small}$$

$$I_{yy} = \frac{A}{12}\left[m^2 + \left(\frac{tn}{H}\right)^2\right]$$

$$= \frac{A}{12}m^2 \text{ when } t/H \text{ is small}$$

Load cells

(Continued from page 49)

peated in several forms by other companies.

Large tanks use load cells in a very simple form of support with an output signal proportional to weight. Some of the most awkward mounting problems have come because of space limitations.

Portability. Portable equipment demands characteristics that encourage the use of load cells, such as smallness, lightness and rigid construction. Cox & Stevens Aircraft Company have made portable aircraft weighing equipment using load cells for several years; Harnischfeger Corp. have successfully mounted electric load cells in crane-scale hook assemblies. Electric transmission of output signals is particularly convenient for portable equipment. The principal problem is protecting the cells against accidental overloads, particularly those from shock or impact.

Indicating, recording, and control. High-speed electronic instruments, developed and refined to a high degree for allied industrial measurements (such as temperature, flow and pressure) have been readily adapted to the special problem of measuring and recording weight. They are available as round-chart, strip-chart and indicating instruments. Various means are also available for making permanent digital records (either as printed or punched cards) for later automatic processing by accounting machines.

One of the most important techniques possible with load cell instrumentation is multiple-point measurement, wherein several load-cell signals are measured sequentially on a single recorder or indicator. On an Atomic Energy Commission installation, the weight of material in each of ten separate storage locations is recorded on a single instrument.

Batch addition of several ingredients in preset amounts can be automatically controlled on a weight basis. In one foundry, for example, three kinds of sand are fed in prescribed weights into the cradle. Load cells connect to the control panel, which automatically switches sand hoppers as the preset weights are added. ★

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New products
continued

Solenoid valves

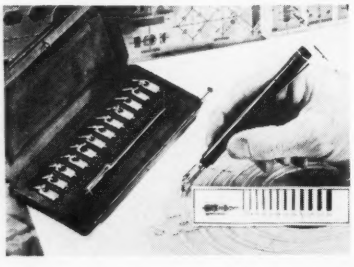
A new low-cost line of solenoid valves has been introduced by the **J. D. Gould Co.** Among their features are molded epoxy resin waterproof coils, unbreakable piston rings and guided pilot valve seats.

The line consists of general service valves in nine sizes from ⅜ in. to 3 in.

The valves are packless, 2-way, piston operated and are designed for pressures to 400 psi and temperatures to 340 deg F. (208)

Specialized pen kit

The impressive increase in use of schematic drawing templates has prompted the design of a specialized pen kit intended to wring the last drop of speed and uniformity from them. This kit, **Omnigraphos,** teams up a fountain barrelled



pen with twelve width-set tubular nibs able to draw or match ink lines from 0.3 mm to 2.5 mm—regardless of the curves thrown at it by the most complicated templates. The unusual offset angle of the interchangeable nibs permits them to hug guide-slot walls tightly, thus increasing speed and accuracy simultaneously. (209)

Thermistor probe assemblies

Nine specially designed thermistor probe assemblies are available from **Fenwal Electronics Inc.**

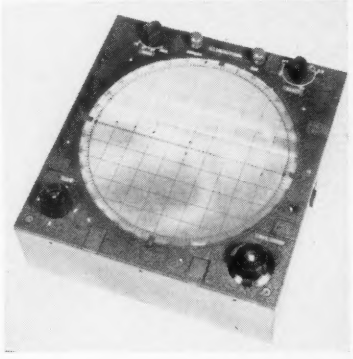
Applications of the probes include air, oil and fuel temperature measurement, surface temperature measurement, and liquid level indication and control. The probes are widely used in missile telemetering circuits and other places where precise and accurate control is demanded.

Thermistor probes are providing many advantages. Since each is a completely designed assembly, user's production and testing costs are often lowered. Not only is the probe ready to install but it can be provided to meet specific design tolerance requirements. (210)

Dead reckoning indicator

A pilot's dead reckoning indicator is now available from **Daystrom Ltd.**

It is a display device intended for use as a short range aircraft navigational aid which may be portable or permanently mounted vertically or horizontally. It features a translucent screen scribed with a grid of co-ordinates and a compass rose. A lamp holder or "bug" is driven beneath the screen by three servo-



motor systems. Two of them position the bug at any point or locus of points while the third servo-motor system rotates it through 360 deg. The location of the bug, an arrow image, and its alignment relative to the grid represent the possible position of the aircraft and its heading in the area covered by the screen. Range scales available are 2.5, 5 and 50 miles. (211)

Air conditioner thermostat

The new **Robertshaw** electric thermostat is a single-pole, single-throw, reverse-acting unit for air conditioners, refrigeration and heater applications.

The unit is also suitable for pilot or single duty applications. It is designed for three-wire systems, and is available in temperature ranges to 550 deg. F in a compact design which measures less than 3 in. in greatest dimension. (212)

(Continued on page 72)

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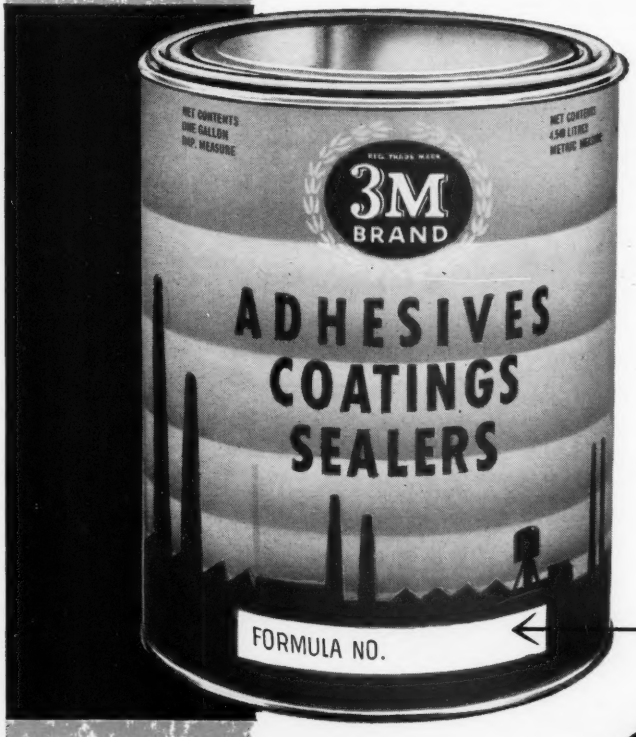

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New products
Continued

Silane Finishes

How the proper silane finish can benefit users of reinforced plastics in all fields is told in **Union Carbide's** eight-page illustrated booklet, called "From flying machines to flyrods, from rockets to radios." It describes how the company's silane finishes A1100 and A172 put force in reinforced plastics. Both end users and laminators of glass reinforced polyester, phenolic, epoxy or melamine resins will be interested in learning how initial strength, moisture resistance, heat stability and electrical properties and strength/weight ratio of their products can be improved by use of bonding agents. (213)

Towing hook

A new towing hook for all late model trucks has been designed by **H. K. Porter Co. Inc.**

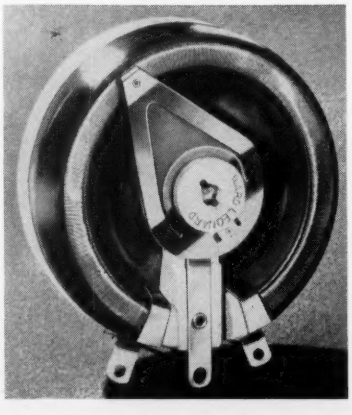
Now in production, this new towing hook has been designed for mounting

directly under the frame of the truck. More important, it can be mounted without cutting into the frame or the body. In the past, because of body design in the truck field, it has been necessary to cut into the body to install a towing hook.

The new undermount towing hook is forged of steel. It is relatively light in weight and strong enough to withstand the great shock required of a towing hook. (214)

Ring rheostats

Ward Leonard has two new additions to their standard line of ring rheostats. Embodying many proven design features found on smaller sizes, these new 100 and 150-watt rings are recommended for rheostat or potentiometer use in electronic, industrial and other control equipment where smooth, gradual resistance change is essential.



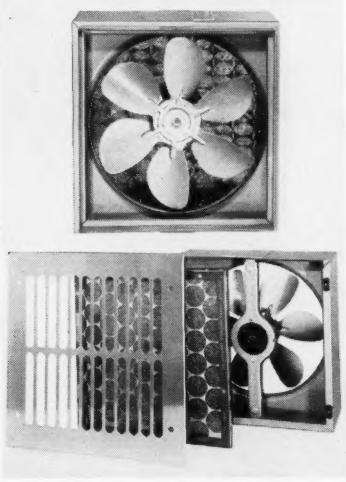
Design features include: "twin-shoe self-lubricating contacts; molded ceramic base and core featuring high density, low porosity and high dielectric strength; vitreous enamel permanently bonding base and core and securing high stability resistance wire, minimum back-of-panel depth. (215)

Snap-acting switch

Panel mounting flexibility is offered by the new **Cherry** snap-action switch. Using the mounting stud as a terminal connector, it permits installation on one side of the panel and wiring from the other. A rubber grommet on both sides provides positive panel insulation. The machined stud terminal is riveted to the contact brackets for rigid installation and positive continuity. Simple electrical connections are made by eyelet connectors on the wires and secured by locknuts. (216)

Packaged cooling

These completely packaged **McLean** assemblies eliminate fussing with rung fans and their accessory components. The same filtered and protected ventilation is provided with the following major advantages: 1. Square mounting—no round holes to cut. 2. Built-in filter case. 3. Same fan may be used to either suck or blow air. 4. May be mounted inside or outside cabinet. 5. Filter optional-permanent or disposable type.

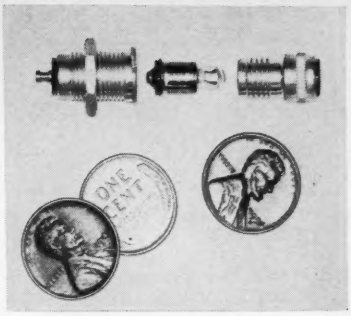


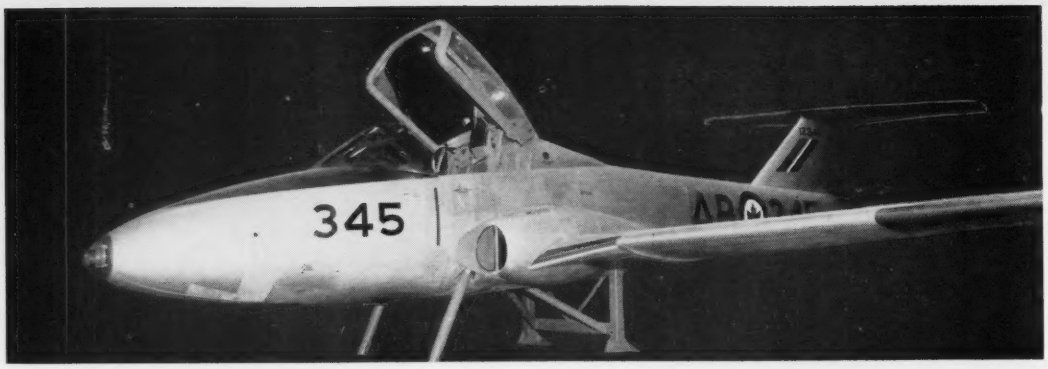
The fans are completely encased for protection and for attractive appearance if mounted externally. Fan orifice is recessed for maximum air delivery—yet case may be flush-mounted. (217)

Indicating lights

New sub-miniature incandescent indicating lights are being manufactured by the **Sloan Co.** for indicating and warning circuits in computers, data recording and control instruments and aircraft control panel indicating and warning applications. The low cost, full 180 deg visibility lights are designed for use in printed circuit boards, missile control and test stand systems, shipboard use and for applications in petroleum field test stations.

Available with nylon lenses in red, white, blue, green and amber, the new subminiature lights have replaceable standard bulbs and offer users a choice of eight different mounting configurations and body types. They have proven especially useful in missile test stand and airborne applications as they are designed for reliable operation in high ambient temperatures. (218)





Mock-up of the CL-41 was made to check design arrangement and has been reviewed by the RCAF, USN and USAF.

Side-by-side jet trainer is all-Canadian

The CL-41 announced by Canadair

The development of a modern side-by-side basic jet training aircraft (the CL-41) has been announced by Canadair Limited of Montreal. Two flying prototypes of the aircraft, which has been completely designed and developed by Canadair, are now in production with completion scheduled for the fall of 1958.

The CL-41 incorporates all the desirable features of a basic jet trainer, to take the student from the ab initio through the basic flight training stages.

Some of these features are: side-by-side seating for the instructor and trainee; ejection-type escape seats; a jettisonable canopy sequenced into the ejection escape system; pressurized cabin; complete instrumentation, including two blind-flight panels; a bird-proof windshield.

The CL-41 will be powered by a single turbo-jet engine of the latest lightweight design and low specific fuel consumption. The static thrust will be about 2,000 lb. Dimensional and performance data are given.

The fuel load of approximately 2,000 lb allows the airplane a two-hour training flight of circuit and landings at sea-level without refueling. At altitude, the same amount of fuel (less 10% for reserve) will give the aircraft a range of 800 nautical miles at an average speed of 300 knots.

A full-scale mock-up of the CL-41 has been constructed as a check on the design arrangement. Representatives of the RCAF and U. S. Navy and Air Force have subjected the mock-up to a systematic review.

A 1/5 scale static model has been thoroughly wind-tunnel tested with extremely satisfactory results, while two 1/15 scale dynamic models have been thoroughly tested in the spin tunnel of the National Aeronautical Establishment at Ottawa.

These tests show that the spin and recovery characteristics satisfy both British and U. S. criteria. Since the two criteria differ appreciably in basic approach, it is something of an achievement for the CL-41 to meet both!

Experience in other countries (particularly by the RAF in Britain) shows that it is quite feasible, and even more economical, to train pilots ab initio using an aircraft as large as the CL-41. Pilots could thus graduate from the ab initio CL-41 to the Canadair T-31 and then to a transonic or supersonic aircraft. ★

Design gross weight	6,250 lb
Span	36 ft 4 in.
Wing area	220 sq ft
Wing loading	28.4 lb per sq ft
Length over-all	31 ft 11 in.
Height over-all	9 ft

Take-off ground run	1,000 ft
Take-off (over 50 ft obstacle)	1,700 ft
Landing distance (over 50 ft obstacle)	1,800 ft
Stalling speed (intermediate weight)	62 knots
Max speed (military power at intermediate weight)	400 knots
Max speed (continuous power at intermediate weight)	388 knots
Full load	2,000 lb (approx.)

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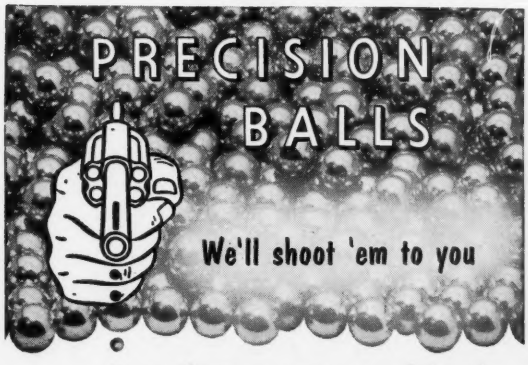

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(will stand up better than nickel and other finishes)

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New Products

Continued

Silver-clad stainless

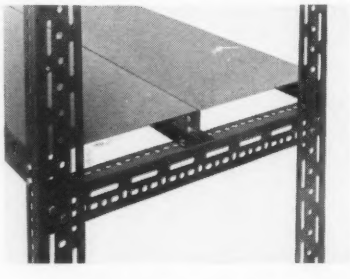
Silver-clad stainless steel is a new addition to the clad metals line of **American Silver Co.** It is finding wide use as an efficient, inexpensive and durable electrical contact material.

The silver-clad stainless steel is made by metallurgically bonding a thin layer of silver to type 430 stainless steel. The silver supplies excellent electrical contact properties. Since only a small amount of this precious metal is used, vast economies are effected. The steel supplies a durable, workable low-cost base metal. The resultant clad metal is extremely resistant to corrosive atmospheres. (219)

Steel panel shelving

A new range of steel panel shelf units has been introduced by **Dexion (Canada) Ltd.** Designed for use with the company's slotted angles, the panels provide greater flexibility in the construction and installation of racking equipment.

Available in widths of 6 in. and 12 in., the panels come in spans as large



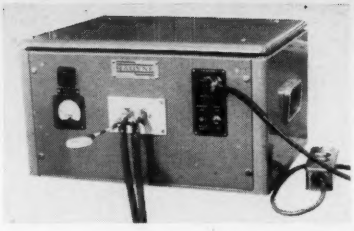
as 8 ft. They can accommodate loadings up to 100 lb. sq. ft. By a clever arrangement in the boltings, the need for cross sway bracing is eliminated. Rustproof and painted in grey, the new panels are strong, completely rigid and can be built to any required depth on a unit principle. (220)

Small induction heater

The **Radne** (Model C3) induction heater was specially designed for small soft soldering operations on production line assembly.

The terminal output of the generator is fixed at approximately 700 volts, ensuring that the generator can easily be loaded with any practical work coil within the range for which the unit was designed.

The output frequency of the generator



is fixed at approximately 2 mcs. No cooling water is necessary when used in intermittent operation. The work coils can be made of solid copper rod and covered with silicone glass sleeving when not cooled. If used for continuous operation, the work coils can be made of copper tubing and cooled with a water supply of one pint per minute. (221)

Casting resin

A flexible casting resin which sets at room temperature has become available.

The new material, **Maraset** resin No. 639, produces castings ranging from the flexibility of plastisol to the toughness of hard rubber, with the added convenience of polymerizing without heat. However, when more rapid setting is desired the resin lends itself to a combination of room temperature cure and short oven cure.

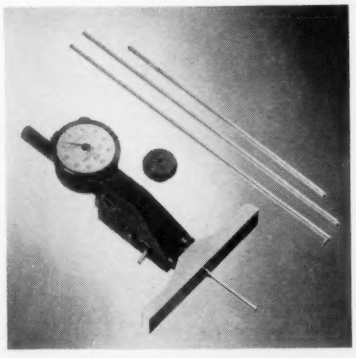
The resin is odorless, dimensionally stable, with good chemical resistance and excellent recovery characteristics. It adheres to plastics, metals, ceramics, glass laminates and other materials. (222)

Depth gauge

The **Mueller** dial depth gauge is designed to locate a groove and measure the width of the groove in one setting. The width of the groove can be read directly off the indicator.

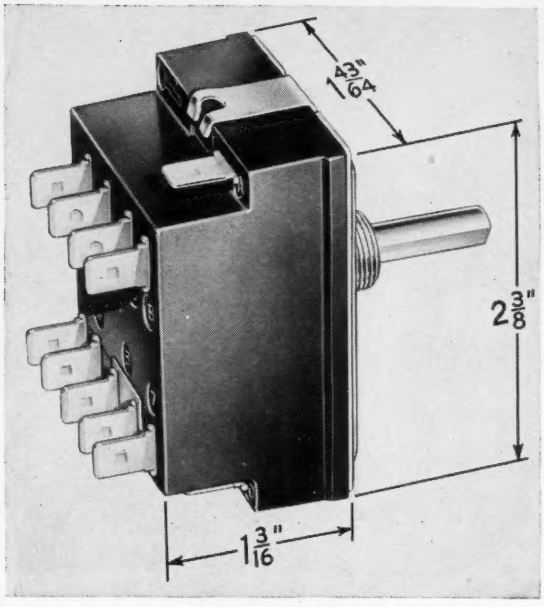
The gauge is fully adjustable and above all, reliable. It is light-weight easy to operate and perfectly balanced.

The measuring rods are made of hard-



ened drill rod and perfectly finished. One end is flat and lapped. The opposite end has a radius. (223)

Soreng rotary selection switches meet your design requirements economically



Here's a versatile unit that can be depended upon to provide positive operation on appliances, home laundry equipment, vending machines plus a host of other applications. It is a high production type switch designed to satisfy the cost-conscious volume user, yet it is rugged enough to withstand grueling industrial service. For more complete information, write for bulletin on Model 776.

Features:

- Two SPDT and three SPST switches
- Shaft actuated push-pull switch
- Positive indexing up to eight positions
- Snap action provided by spring loading
- Silver plated spade terminals with bussing available between any combination of terminals
- Specially designed spring construction
- Shaft stroke up to 360 degrees

Rating:

Listed by Underwriters' laboratories
Model 776-1 . . . 10 amp., 125/250 Volt A.C.
Model 776-2 . . . ½ h.p., 125/250 Volt A.C.

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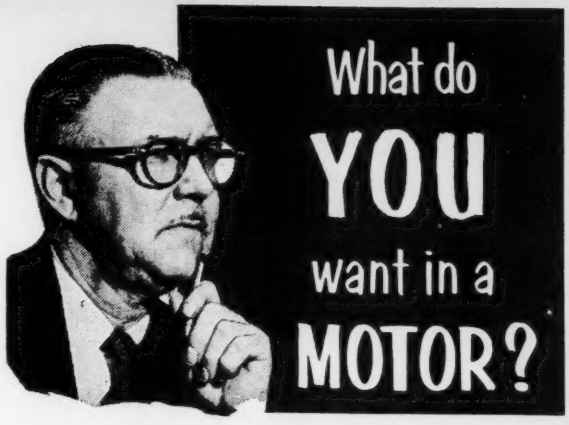
SORENG
COOKSVILLE, ONTARIO, CANADA



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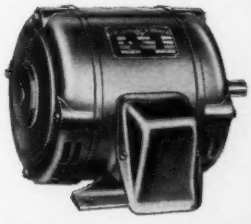

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Book Department

In **Work Sampling** (Wiley) Dr. Ralph M. Barnes (an acknowledged leader in the field of industrial engineering) offers a thorough analysis of the work sampling technique, and provides an execellent reference and guide to work sampling studies. The fundamentals essential to an understanding of this technique are clearly and lucidly explained and specific directions are offered to show how to apply the method in an individual office or factory. The book also offers detailed results of research done in the field (including Tippett's pioneering paper on the subject), and provides invaluable case histories (contributed by men of national prominence in the field) that illustrate the application of the technique in actual situations.

Resistance of Materials (4th edition) by Fred B. Seely and James O. Smith (Wiley) is essentially a new book. It features a radical change in the usual approach to the subject and in the selection and organization of the topics covered. It aims at making the theory of resistance of materials more self sufficient and at developing more logical methods of analyses and design.

Featured in this revision are: An early introduction to the inelastic behavior of material, especially useful in obtaining the limiting or ultimate loads on certain types of members, such as riveted and welded joints, beams or columns; a more realistic concept of the safety of a member; a more rigorous and flexible treatment of combined stresses that can be taught at any time in the course; the use of interaction curves, introduced as a means of solving problems involving combined loads; early introduction and more rational treatment of the buckling strength of columns; a large number of new problems and new figures.

Tape wound cores

Tape wound cores are illustrated and described in a new, two color, eight page catalog recently published by G-L Electronics. The informative catalog (Bulletin TB-102) describes the three types of core material from which the precision-made tape wound cores are manufactured, including O Orthonik, a grain oriented 50% nickel, 50% iron alloy which has an exceedingly rectangular hysteresis loop; H Hymu 80, a non-oriented rectangular hysteresis loop material containing 4% molybdenum, 79% nickel and 17% iron; and B Hymu 80, a material having the same chemical composition as the rectangular loop H Hymu 80 but processed for very high initial permeability and low dynamic core loss.

No time like the present

LOTS OF YOU ENGINEERS have the nucleus of an article tucked away in a drawer somewhere, either in the form of rough notes or as a rough typescript.

The reason, of course, that you haven't done anything about it is because you probably feel that nobody will be interested in publishing it—so why do all the work necessary to get it in shape for nothing?

There is somebody interested in your technical article: DESIGN ENGINEERING is always on the lookout for suitable contributions. Not that we are short of material, mind you. But it does seem a pity that good stuff should not see the light of day.

Why not act at once and tidy up that article, get it typed and submit it to DESIGN ENGINEERING? If we like it enough to publish it, you will be paid. Not a fortune, perhaps, but enough to make it worth your while.

And think of the personal satisfaction of seeing yourself in print.

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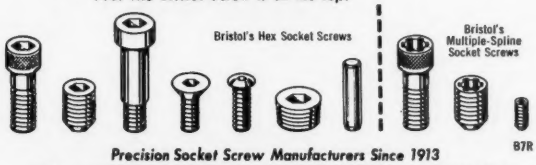
At a glance the two set screws look alike. But identical twins can have very different characters. The extra built-in quality of Bristol screws may not show on the surface, but it does show in longer life, better performance and greater product acceptance. All Bristol screw products are manufactured from specially selected alloy steel, expertly heat-treated, accurately machined to closer tolerances and inspected with painstaking care. The result is perfect fit that speeds assembly and won't work loose. Write our Socket Screw Division for information.

P.S. The Bristol Screw is on the top.



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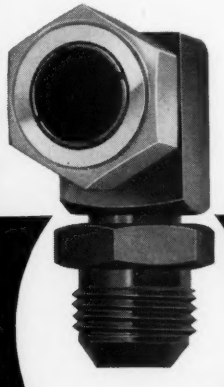

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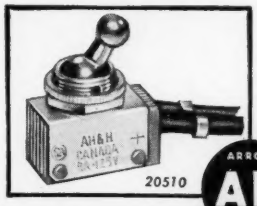

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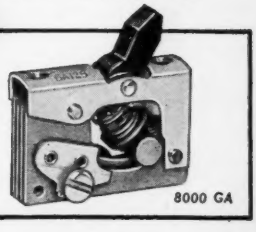

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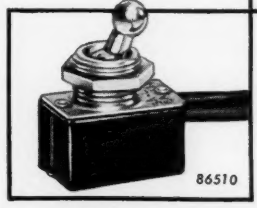

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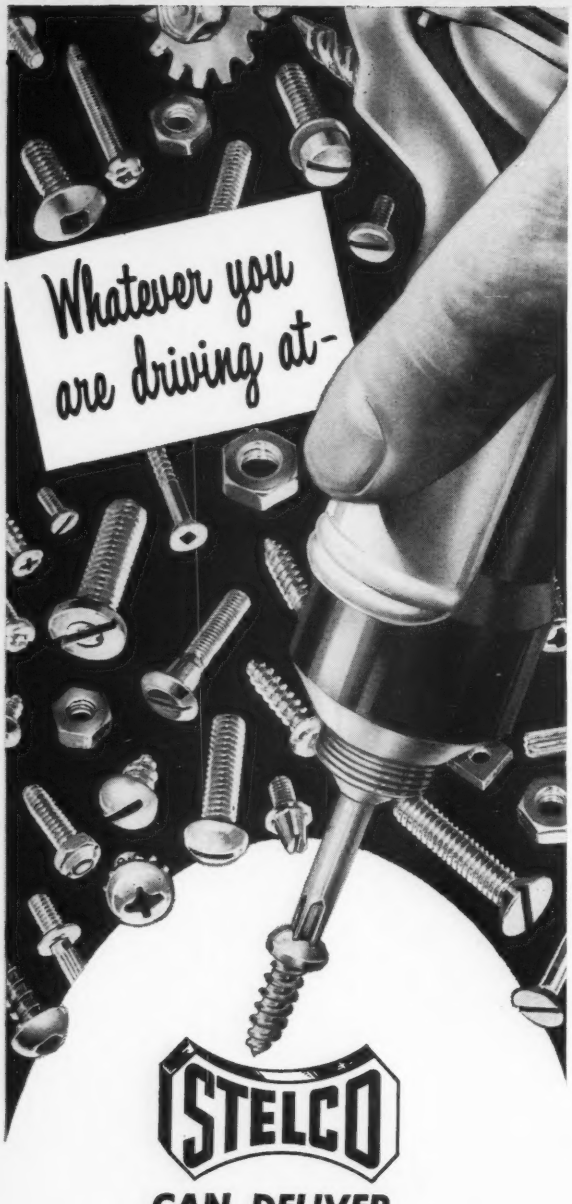

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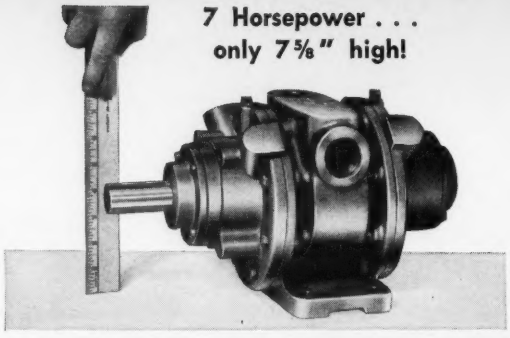

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Has foot, also tapped holes for flange mounting to your machine. Use as original equipment or in plant to drive hoists, mixers, pumps, fans, etc. Priced at $200.

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See Catalog in Sweet's Design File

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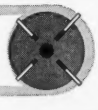

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HYDRAULICS — PNEUMATICS — CONTROLS

Advertising Index — May

Editorial

Design and research emphasized

It is interesting that the engineering studies at McMaster University have been planned with the prime object of educating designers and research engineers.

The curriculum puts emphasis on fundamental science and mathematics; gives opportunities for studying the humanities; makes provision for the fact that engineers must be capable of facing new and unfamiliar situations.

Fifty students enrolled last September for the four-year course that leads to the degree Bachelor of Engineering (B.Eng.) but the engineering facilities have been planned for a total enrolment of 550 students, a figure that will probably be reached by 1962.

Data sheets

Every day, the design engineer is called on for technical information: if he can have this at his fingertips, so much the better.

We have therefore started a new feature this month—a Data Sheet. This particular one gives the section properties of some often-used shapes. A similar data sheet will appear each month, so if you feel strongly that certain subjects should be covered, please let us know.

It is even possible that some of our readers have (over a period of years) collected just the kind of information that would be most useful as a data sheet for design engineers. It would be a great help if they were to submit this material to us.

How to produce a design engineer

In an interesting SAE talk, R. S. Frank (Caterpillar Tractor Co.) made these points: College teaches a man the engineering fundamentals; industry has to teach him to apply these fundamentals to practical machines. In the process he must learn to get along with people; to sift and analyze data and ideas; to reach the best compromise of all factors involved.

Ability to weigh opinions carefully (and judge each fact in relation to all the facts) is a prime requirement for a successful design engineer. Only with these abilities can he arrive at the best compromise—the end point of every practical design effort.

William Morse.

INTAKE TO THE FUTURE

Beyond this screen, which straightens turbulent air flows, Orenda can test run advanced engines in an atmosphere equivalent to 100,000 feet of altitude.

This new high altitude tunnel is another of the major programs at Orenda for research into air-breathing engines over the widest range of speed and altitude.

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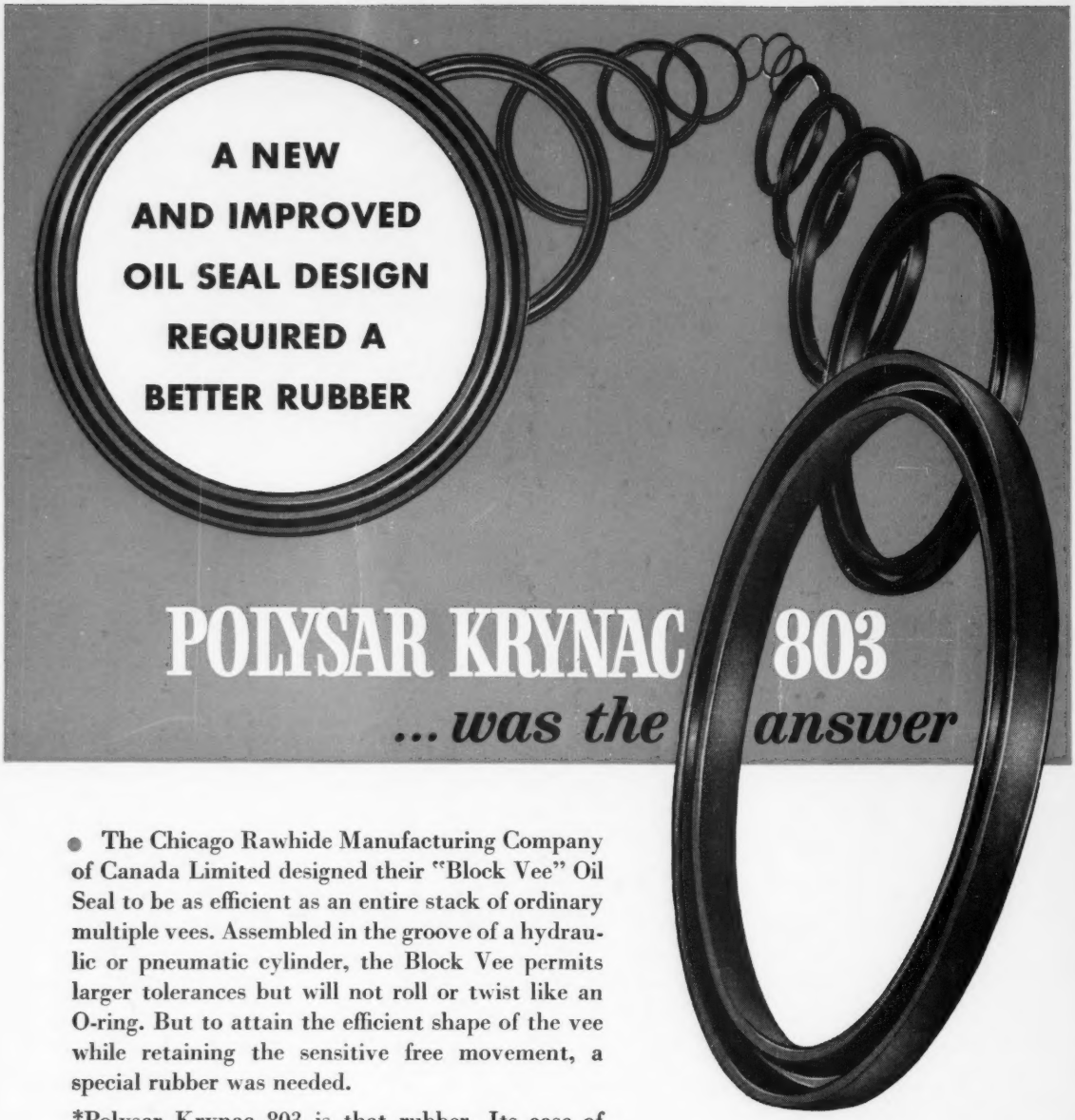

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● The Chicago Rawhide Manufacturing Company of Canada Limited designed their "Block Vee" Oil Seal to be as efficient as an entire stack of ordinary multiple vees. Assembled in the groove of a hydraulic or pneumatic cylinder, the Block Vee permits larger tolerances but will not roll or twist like an O-ring. But to attain the efficient shape of the vee while retaining the sensitive free movement, a special rubber was needed.

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Polysar Krynac 803 is one of a variety of nitrile (oil resistant) rubbers made by Polymer Corporation Limited . . . producers of 24 synthetic rubbers and latices for manufacturers throughout the world. To learn how these rubbers can help you, write to our Sales and Technical Service Division.

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